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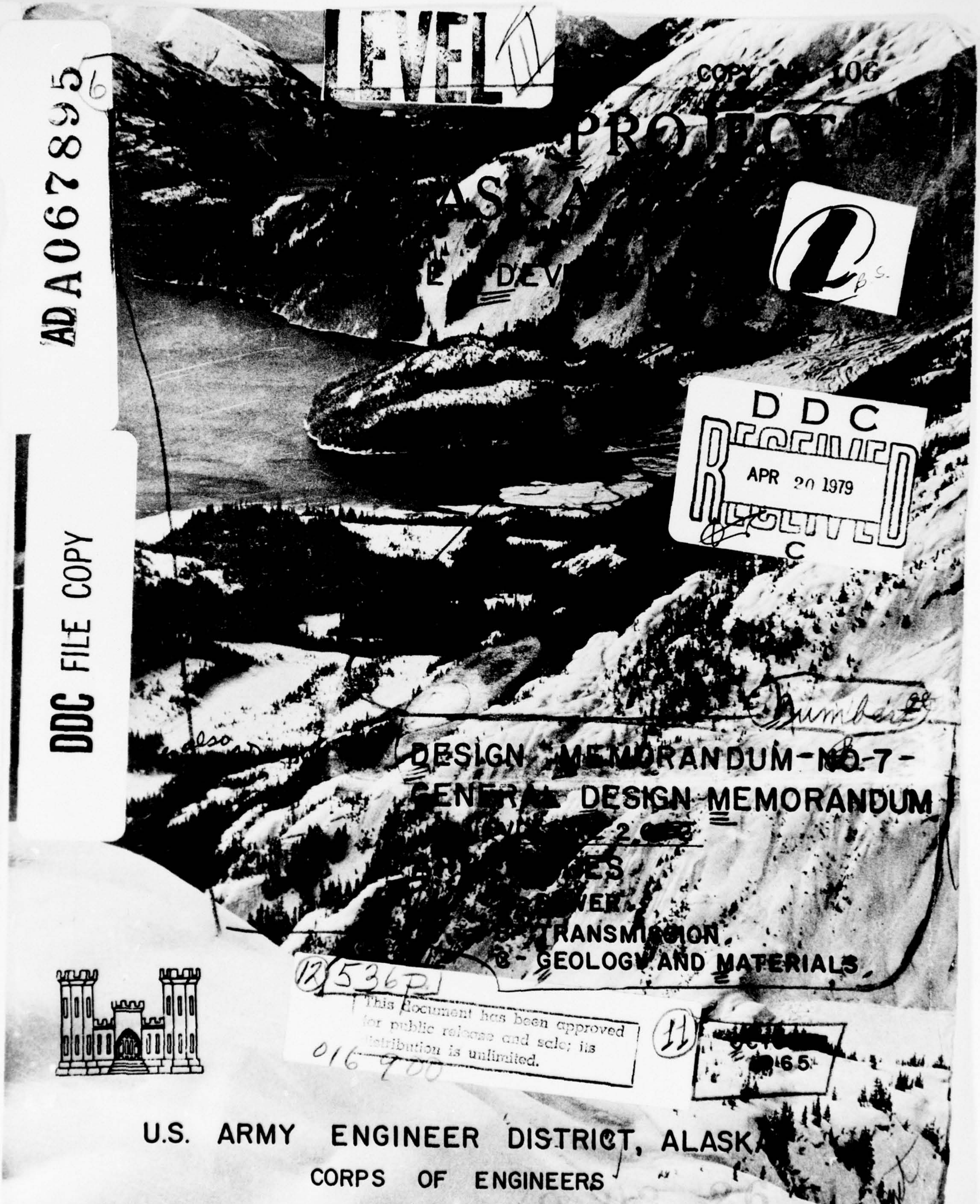

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PROJECT

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DESIGN MEMORANDUM NO. 7

GENERAL DESIGN MEMORANDUM

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U.S. ARMY ENGINEER DISTRICT, ALASKA

CORPS OF ENGINEERS

APPENDIX A

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SNETTISHAM PROJECT, ALASKA

DESIGN MEMORANDUM NO. 7

Appendix A - Power

SNETTISHAM POWER STUDIES
PERTINENT DATA - POWERPLANT

Location:

Near mouth of Speel River, 28 air miles southeast of Juneau, Alaska.

Power Installation:	**Long Lake**		**Crater Lake**	
First stage development:				
Number of units	2			
Installed capacity	40,600			
Capability-115% rated capacity, KW	46,700			
Second stage development:				
Number of units			1	
Installed capacity, KW			20,300	
Capability-115% rated capacity, KW			23,350	
General:				
Pool elevations, ft msl:				
Normal power pool	843		961	
Maximum power pool	895		1022	
Minimum power pool	720	1/	828	1/
Maximum uncontrolled, spillway design flood, cfs	21,300	el. 903		2/
Tailwater elevations, ft msl:				
Normal tailwater		0.5		
Maximum tailwater		16.0		
Minimum tailwater		- 1.0		
Reservoir storage, acre-feet				
Storage upper limit	484,000		121,000	
Storage lower limit	232,000		40,000	
Active storage	252,000		81,000	

1/ Physical limitations of intake conditions may limit minimum pool elevation.
2/ Not yet determined.

SNETTISHAM POWER STUDIES
PERTINENT DATA - POWERPLANT (Cont'd)

	Long Lake	Crater Lake
Generation:		
Prime power, KW	25,700	12,100
Primary energy, KWH/yr	225,000,000	106,000,000
Dependable capacity, KW	46,700	23,350
Load Factor	55	52
Turbines:		
Type	Francis	Francis
Head, ft:		
Mean operating	848	967
Maximum	895	1022
With standard project flood	901	-
Minimum	721	828
Capability, h/p, at rated head	32,000	
Turbine discharge, cfs, rated head (full gate)	510	1/
Synchronous speed, rpm	514	
Generators:		
Rating KVA	22,555	
Power Factor	.9	
Rating, nameplate, KW	20,300	
Rating, overload, (115%), KW	23,350	

1/ Design not final

SNETTISHAM DESIGN MEMORANDUM NO. 7
GENERAL DESIGN MEMORANDUM

Appendix A - Power

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EXHIBITS

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SECTION 1

INTRODUCTION

SNETTISHAM DESIGN MEMORANDUM NO. 7
GENERAL DESIGN MEMORANDUM

APPENDIX A - POWER

SECTION 1 - INTRODUCTION

1-01 PURPOSE:

Appendix A to Design Memorandum No. 7 contains the results of engineering studies, criteria, supplementary data and information supporting the proposed accomplishments of the recommendations given in the main report. Power developments of the Snettisham project, in relation to Juneau's power market, are determined and evaluated. Detailed studies and investigations made to establish the recommended power installation are presented and design criteria, power characteristics, power output and utilization, comparative evaluation of alternative power costs and related economic factors are set forth. Statements regarding project authorization and a resume of prior reports tracing the legislative and research history prior to initiation of general design memorandum studies for the Snettisham project are contained in Section 1 of the main report. Studies to determine the scope of the project were presented in Design Memorandum No. 3.

1-02 GENERAL:

a. Snettisham powerhouse will be located about 28 air miles southeast of Juneau, Alaska, in the Tongass National Forest near the mouth of the Speel River. The project will not affect fish or wildlife resources, there are no requirements for flood control or for maintaining live streams at the lake outlets and recreation potentials are minor; therefore, the design is based solely upon power production and no other function has been assigned. The initial stage will develop the resources of Long Lake. As power demand

in the Juneau area increases, Crater Lake, the second phase of the overall project will be developed to supply the additional power. The complete project will consist of a single powerhouse containing 3 units with an installed capacity of 60,900 KW. Ultimate production will be an annual firm output of 331 million kilowatt-hours per year with an estimated non-firm potential of 23,200,000 kilowatt-hours per year. Juneau area and project location are shown on Plate 1.

b. Basic power market information, load growth data and alternative power values were furnished by either the San Francisco Regional Office of the Federal Power Commission or the Juneau office of the U. S. Bureau of Reclamation. The data were supplemented and updated with actual records of the local distributor for the Juneau area. See Exhibits 2, 4, 5 and 7.

1-03 COORDINATION WITH OTHER AGENCIES:

a. Federal Power Commission - The San Francisco Regional Office of the Federal Power Commission was furnished information on the general status of the project when the authorizing document was written. General agreement was obtained as to the selected site location, normal pool elevation and installed capacity. The Federal Power Commission furnished alternative power values for determination of benefits as stated in Exhibit 2. The FPC also provided the power values used for scoping the project (Exhibit 4) as presented in Design Memorandum No. 3. The question of adequate reserves was also coordinated with the Federal Power Commission (Exhibits 1, 2 and 3). In these letters, requests and explanations are given for reserve capacity, available firm power and alternative value of power.

b. Bureau of Reclamation - In accordance with the March 1962 agreement between the Department of the Interior and the Department of the Army, the Corps of Engineers will design and construct the project, which, upon completion, will be operated and maintained by the Bureau of Reclamation. The Bureau's prime responsibility will be to operate and maintain the reservoirs, penstocks, powerplant and transmission lines. The Bureau also has the responsibility of marketing the power. Close liaison has been maintained with the U. S. Bureau of Reclamation to facilitate joint agreement in project development. The Bureau has provided transmission line criteria, load growth data and general information as well as suggestions for project improvement based on experience gained through operation of Eklutna and other projects.

1-04 PREVIOUS STUDIES AND PROPOSED POWER INSTALLATION:

The power potential of Crater and Long Lakes has been investigated by both private and governmental interests. The first investigations were made in 1913. In 1922, a second investigation was made and in 1928 extensive investigations were carried on by a Mr. George T. Cameron. The U. S. Bureau of Reclamation began field investigations of the project in 1958 and the feasibility report was completed in July 1959. The report titled, "Crater-Long Lake Division, Snettisham Project, Alaska," was published early in 1961 as House Document No. 40, 87th Congress, 1st Session. Power investigations and studies performed to complete the feasibility report recommended a three stage project of three units with a total installed capacity of 48,000 KW. Shortly thereafter the potential industrial load upon which the project feasibility has been based was eliminated by the decision of the Georgia Pacific Alaska Corporation to forego construction of a newsprint mill in the

area. This situation created a substantial change in assumed marketing conditions for the Snettisham project and precipitated a review of the plan of development and economic feasibility. The project was reanalyzed and a reappraisal recommended an increase in installed capacity to 60,000 KW with only minor revisions in other phases of the project; however, the authorizing document and substantiating material called attention to the possibility of project improvement with a dam at the Long Lake outlet. Power and regulation studies conducted by the Corps of Engineers have shown that an eighty-foot dam to elevation 895 will yield maximum net benefits. The presently recommended project, as outlined in Design Memorandum No. 3, is a two stage plan with three equally sized units and a total installed capacity of 60,900 KW. The following tabulation gives pertinent comparative project and powerplant data:

Item	USBR 1958	USBR 1961	CofE 1965
Generators rated Capacity KW	48,000	60,000	60,900
Power Factor	0.9	0.9	0.9
Type of Turbine	Francis	Francis	Francis
Turbine rated Capacity HP	65,760	82,200	83,430
Synchronous speed, RPM	1/	1/	514
Initial Installation			
Units Installed	1	1	2
Skeleton Units	2	2	1
Plant rated Capacity KW	16,000	20,000	40,600
Ultimate Installation			
Units Installed	3	3	3
Plant rated Capacity KW	48,000	60,000	60,900
Overload Capacity KW	1/	1/	70,000
Maximum Pool			
Long Lake	815	815	895
Crater Lake	1022	1022	1022
Minimum Pool			
Long Lake	650	647	723
Crater Lake	820	820	828

1/ Unknown

SECTION 2

POWER MARKET

&

LOAD GROWTH

SECTION 2 - POWER MARKET AND LOAD GROWTH

2-01 POWER MARKET

The market for project power would be domestic, commercial, industrial, and incidental electrical loads in the Juneau power market area. Present Juneau industries are built around governmental operations and the utilization of the natural resources of fish and forests. Gold mines and mills were once major users of power but are now dormant because of adverse economic factors. Establishment of a pulp mill in the Juneau area would increase utilization of timber resources and increase industrial power demand. Justification for the project is based on the future power needs of residential, commercial, small industrial and public agency users. The power market area for the project is limited by two factors: first, adverse topography and heavy forest cover shorten the distance of economical power transmission; and second, electrical demands in Juneau and vicinity are expected to require the entire plant output. The market area to which power could be delivered extends northwest of Juneau to the southern reaches of Lynn Canal, west to include all of Douglas Island, northeast to the Taku River mining district, and southeast to the Tracy Arm mineral zones. Transmission distances in any direction would not exceed 60 miles.

a. Geography - The Juneau trading area extends from Cape Fanshaw to Glacier Bay along the mainland and includes Douglas Island and the north and eastern sides of Admiralty Island. Gastineau Channel, a narrow, salt water channel, separates Douglas Island from the mainland. The City of Douglas, located on Douglas Island, is connected to Juneau by 2 miles of paved highway and a steel bridge across Gastineau Channel.

Mt. Roberts and Mt. Juneau rise abruptly behind Juneau to elevations of 3,819 feet and 3,576 feet, respectively. Beyond these peaks to the east, higher peaks and the Juneau ice fields are encountered. To the west, Douglas Island, Admiralty Island and Chichagof Island intervene between Juneau and the open Pacific Ocean some 80 miles away. To the north, Lynn Canal and Favorite Channel, long fingers of the sea, extends 65 miles from Tee Harbor, near Juneau, to Haines. Haines is the terminus of the only Alaska Highway link to southeast Alaska. To the south, 900 miles of islands, salt water passages and open sea, separates Juneau from Seattle, Washington.

b. History - The northern part of southeastern Alaska was explored in 1794 by Vancouver, the English navigator. The area was nominally under Russian control until 1867 when the United States purchased Alaska. There was little activity in the Gastineau Channel area until the discovery of gold bearing quartz and rich gravels in the Gold Creek Basin in the summer of 1880. Numerous locations were made during the following year, including quartz claims on Douglas Island. Development of the large, low-grade ore bodies was rapid and the Juneau area soon became the most important producer in Alaska. In 1900 the seat of government was officially transferred to Juneau from Sitka, although the actual move was made gradually over several years. The area has experienced a steady growth, with minor fluctuations, since its first settlement. In spite of complete cessation of mining in 1944 growth has continued. Increasing governmental activities are chiefly responsible for this situation. Fishing, lumbering and tourism presently provide an important diversification of the economic base. The surrounding untapped timber resources are expected to play an important part in the area's future economy.

c. Climate - The outstanding features of Juneau's climate are heavy precipitation and mild temperatures. Normal annual precipitation is 90.1 inches, although this varies markedly with little change in altitude or distance. Annual snowfall averages about 100 inches. Winter rains and mild temperatures normally preclude a large accumulation of snow on the ground. Juneau has a July mean temperature of 56°F and a January mean of 29.5°F, the latter about the same as that of Salt Lake City, Utah. The lowest temperature recorded at Juneau was -15°F and the highest was 89°F. At the Juneau airport, 8 miles northwest of the city, the range in temperatures is slightly greater and the normal annual precipitation is about two-thirds that of Juneau. There is an average of 11 days each year of minimum temperature below zero at the airport compared with 2 days at Juneau.

d. Juneau - Juneau was built, for the most part, on the lower slopes of Mt. Juneau and Mt. Roberts, the city making a picturesque appearance against a backdrop of steep mountains. Virtually all of the flat land along the shoreline has been created by a fill of mine tailings. Many of its buildings are supported by wood piling. Although evidence of its early history can still be seen, Juneau is a thriving, modern community. Large office buildings attest to its major source of income. Many new homes, apartments and other buildings are evidence of its continuing growth. Its commercial establishments and professional services can meet practically all requirements commensurate with the needs and it is the primary trading center for the entire area. Utility services are provided by both the city and private companies. The water system is municipally owned. Electric and telephone services are supplied by private corporations. An efficient

voluntary fire department with modern equipment provides fire protection. The Juneau airport, 8 miles northwest of the city, is municipally owned and operated. A paved, 6,500 foot long runway accommodates jets and the four-engine Constellations used by major airlines. Within the city limits a seaplane terminus is the base of operations for local flights to most southeastern Alaska cities and villages.

e. Other communities and facilities - About 50 miles of improved highway, over half of which is paved, provides easy access to Juneau from small communities and rural homesites on the mainland and on Douglas Island. Most of the suburban residents are employed in Juneau. Douglas, the only other incorporated city in that area, is located on Douglas Island. Although it was larger than Juneau early in the century, it is now principally a residential suburb of the capitol. Some commercial services are available in Douglas; however, most shopping is done in Juneau. The City of Douglas maintains its own water and sewer system, streets, etc. Auke Bay is the only other populated area that provides limited commercial and community services. Although small at the present time, it promises to expand rapidly as the Juneau area grows. The Alaska ferry now docks near Auke Bay and is providing increased economic benefits to the entire area due to increased tourist traffic. The entire Juneau area is within the Juneau-Douglas Independent School District. The school facilities are modern and educational standards are rated quite high. A new high school was completed early in 1958 and addition of an adjoining gymnasium and auditorium was recently completed. In addition to the public school system, a parochial grade school is also located in Juneau.

In 1908, the City of Juneau gave the Alaska Electric Light and Power Company a 50-year franchise. Gold Creek hydroelectric plant with an installed capacity of 800 kilowatts was completed in 1914; however, low winter flows precluded firm power. The company continued to supply the winter load with steam engine driven generators until 1917 when the Alaska-Juneau Gold Mining Company (now known as A-J Industries) constructed an 8,000 kilowatt oil-fired steam plant. By 1915 A-J Industries owned 5 hydroelectric plants with an installed capacity of 13,505 kilowatts. Two of these developments, Nugget Creek and Sheep Creek were run-of-river plants and consequently were useless in winter. A 170 foot high concrete arch dam, built in 1915 on Salmon Creek, impounded 19,000 acre-feet of water for use by the two Salmon Creek plants. Total installed capacity of the two plants was 5,600 kilowatts, but usable capacity does not exceed 4,400 kilowatts at present. At the Annex Creek plant, two 1,400 kilowatt units were installed. They are supplied by water from Upper Annex Lake which provides 23,000 acre-feet of storage. A sixth hydroelectric plant owned by the mining company, Treadwell Ditch No. 1 on Douglas Island, had an installed capacity of 1,000 kilowatts but like Nugget Creek and Sheep Creek, had no water supply in winter. The original development of water power at this site was begun in 1882, but generators were not installed until 1922. All these plants were operated at almost full capability until 1942, when mining operations were curtailed. Complete shutdown of the gold mine in 1944 idled a good portion of the generating capacity of the mining company. Until 1957 the industry attempted to maintain mine, mill and powerplants in a reasonable state of repair in anticipation of reopening the mine at some future date. Through disuse, however, waterways of the Nugget Creek and Sheep Creek plants deteriorated

until they are not now in operating condition and the 8,000 KW steam plant is beyond repair. In March of 1962 A-J Industries applied for a 50-year renewal of its Salmon and Annex Creek hydro sites but did not include Sheep Creek, Nugget Creek or Treadwell Ditch. A 25-year license was subsequently issued by FPC in October of 1963 with stipulations requiring rehabilitation of all portions of both sites over a five year period. In 1949 and 1950 the Alaska Electric Light and Power Company replaced the penstock at its Gold Creek plant and installed a new 800 kilowatt hydroelectric unit to supplement the existing installation. No new storage was provided; however, and the units are idle in winter. Only the Gold Creek plant of the Alaska Electric Light and Power Company was built for the exclusive purpose of supplying power to the community. All other capacity may, if needed, be diverted for private industrial uses. Taking cognizance of this fact and its own lack of firm capacity in winter, Alaska Electric Light and Power Company added a 1,250 kilowatt diesel unit at its Gold Creek plant in 1952 and a second identical unit in 1954. In 1965 a 4,120 KW diesel was added, increasing Alaska Light and Power Company firm capacity to 7,390 KW.

The Juneau area with its nearby communities of Douglas and Thane and the rural loads south of the Mendenhall River are served by the Alaska Electric Light and Power Company. Fifty to seventy percent of its total power requirements are purchased from A-J Industries. A-J Industries owns presently installed hydroelectric capacity of 8,400 kilowatts and inoperative hydroelectric and steam capacity of 13,905 kilowatts. The maximum firm generation which these plants could produce without extensive repairs is about 7,200 kilowatts. This dependable capacity is represented by the Salmon Creek and Annex Creek plants. A 23,000 volt transmission system

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interconnects all the mining company's hydroelectric plants with a substation near the old steam-generating plant in Juneau. Through the distribution system of the Alaska Electric Light and Power Company, the utility's Gold Creek plant interconnects with the mining company's power system. During January 1965 the peaking demand for all the interconnected plants was reported as 10,000 kilowatts as listed in Table 1. However, the peak demand listed does not include any power retailed by A-J Industries. Table 2 summarizes the above electric developments of the Juneau area.

The Juneau area has sufficient power capacity to meet its present power requirements; however, the usual benefit of low-cost power from hydro sources is not apparent. Wholesale rates are high, necessitating relatively high retail rates. The Alaska Electric Light and Power Company has paid from 15 to 27.5 mills per kilowatt-hour (depending on point of delivery) for energy purchased from A-J Industries. Average for all energy purchased in 1958 was 17.3 mills. Recent hearings before the State Utilities Commission indicate this figure may average 22.5 mills in the future. The Glacier Highway Electric Association has been paying a flat rate of 22.5 mills per kilowatt-hour for energy purchased from Alaska Electric Light and Power Company. The Glacier Highway Electric Association, an R.E.A.-financed cooperative serves an area north of Juneau which includes Auke Bay. They do not have production capability except for a 125 KW standby unit and purchase all of their energy from Alaska Light and Power Company.

2-02 LOAD GROWTH

In arriving at the power forecast (Table 3 and Exhibit 4) for the Juneau market area, the Bureau of Reclamation considered the factors of future high levels of employment, income and probable development of new

local use industries in conjunction with expansion of existing ones. Greatly increased utilization of the vast timber resources of the Juneau area is anticipated within the next few years. As the State Capitol, Juneau's governmental facilities should undergo continued expansion. With new local use industry and more governmental activities, it is estimated that the 1965 population of approximately 11,000 people will double by 1975. Electricity is presently a well-used commodity in Juneau area homes. Furthermore, average customer use is rapidly increasing each year. A drop in retail power rates with availability of project power could be expected to accelerate the rate of increase in use. Assuming project completion, the average customer of 1975 would probably use 8,000 to 10,000 kilowatt-hours a year. The average use of electricity by commercial establishments is relatively low at the present time; however, there is every likelihood that this use will also increase steadily. Competition has become more keen within the past few years and modern lighting, advertising and display are being used more extensively. New commercial buildings are being built in downtown Juneau, as well as new shopping centers in outlying areas, such as Auke Bay and Douglas. Such new construction incorporates modern design and increased use of electricity. As the capitol of the new state governmental activities continues to grow, a steady increase of Federal Government activities can also be expected. With the lower cost in power, street lighting will become a substantial part of the power load. Small local use industry is continuing to grow to supply the increasing needs of the Juneau area. In the past, the growth of the power market for the Juneau area has consistently been underestimated. However, the Bureau of Reclamation has developed a realistic growth rate in their letter of 24 February, Exhibit 4.

2-03 POWER REQUIREMENTS

Power requirements for the Juneau area are shown in Table 3 and Exhibit 4. To conform with the economic studies shown in Design Memo No. 3, the forecast is expressed in terms of fiscal years. Typical daily, weekly, and annual load shapes are presented in Table 4. From the forecast power requirements and the load shapes as developed it is anticipated that the first unit of Long Lake which is scheduled to go on line during Fiscal Year 1970 will meet demand until 1972 at which time the second unit of Long Lake will go on line. The Long Lake phase will meet the demand until 1979 at which time Crater Lake will come on line. The combined projects will then reach maximum capability in 1983 at which time a new source of power must be ready. Power requirements and scheduling of units is shown on Chart 3 and Table 14.

2-04 EXISTING AND FUTURE RESERVES

As pointed out in paragraph 2-01, the present combined capacity of the Alaska Electric Light and Power Company and A-J Industries is about 14,590 KW (Table 2) including about 4,120 KW of reserve. The present peak demand in the Juneau area is about 10,000 KW. Based on the FPC reserve requirements, the Juneau area will no longer be able to meet demand and have an adequate reserve after demand passes 10,500 KW. The Federal Power Commission recommends that the minimum reserve in any system be equal to the capacity of its largest unit. After demand reaches 10,500 KW (1965 or 1966) and providing no other power source has been added to the system, the area demand will encroach on the 4,120 KW reserve. This will mean that Alaska Electric Light and Power Company must either purchase more production capability or take the risk of inadequate reserves until the

Snettisham project is on line. When the Snettisham project comes on line, it is believed that existing reserves in Juneau will be about 10,000 KW of hydro and 10,000 KW of diesel. The power market study shows only that portion of the total power requirements of the area which might reasonably be supplied by project power. Locally available power wholesales at a high rate at the present time although its actual cost of production is unknown. Therefore, present productive capability has not been considered as competitive with the cost of project power. Project power would thus be used to supply the entire load of the area until fully utilized.

SECTION 3

BASES FOR PROJECT POWER ANALYSIS

SECTION 3 - BASES FOR POWER ANALYSIS

3-01 PROJECT AND SYSTEM OPERATING CONDITIONS:

a. General - The fifty-year economic life of the Snettisham project will span two general power system operational conditions. For purposes of this study, Snettisham development has been separated into two different length periods. The first period contains the full two-stage construction sequence of three unit installation and covers the years when demand is less than plant capability. The load growth forecast indicates that the first period will last approximately thirteen years. The second period includes the balance of the fifty-year economic life with full project capability required. Conditions chosen for each period were assumed to be approximately representative of the entire period.

b. Growth Period - The first construction stage includes all Long Lake features and both of the Long Lake units to meet the Juneau requirements until Fiscal Year 1979. The initial point, with reference to time and system development for power installation studies and evaluation of the recommended power development, has been assumed to be the presently scheduled and earliest completion date, December 1969. The second construction stage will complete the project by adding all features of Crater Lake including a third unit. Full capability of second-stage construction and the project will be reached in approximately 1983. Numerous studies were made of the growth period with variable growth rates and using synthetic inflow patterns as described in paragraph 3-03. A typical summary of operation during the growth period is included as Table 11.

c. Second Period - Although the second period only covers thirty seven years of the economic life, full fifty-year studies of regulation

and power production were made for both Long and Crater Lakes. Period of record flows were used for the detail studies. The first analysis year for Long Lake was assumed to be 1983 and compared to calendar year 1916. In order to maintain compatability of calendar years, the first analysis year for Crater Lake was assumed to be 1980 since the first year of record is 1913. Details of studies during this period are listed on Tables 5 through 10 and shown on Plates 2 through 14.

3-02 STREAMFLOW AND PERIOD OF RECORD

The U. S. Geological Survey collects streamflow records at Long River and Dorothy Creek, near Juneau. Streamflow records used in this study are as follows:

Station	Period of Record	Drainage Area (sq mi)
Crater Creek at Crater Lake Outlet	Feb '13 to Dec '20	11.4
	Jun '23 to Sep '23	
	Jun '24 to Sep '24	
	Jun '27 to Dec '32	
Dorothy Creek near Juneau	Oct '29 to Oct '41	15.2
	Sep '42 to Dec '43	
	Jun '44 to present	
Long River near Juneau	Oct '15 to Sep '24	32.5
	Oct '26 to Dec '26	
	Jun '27 to May '33	
	Oct '51 to present	

These three stations were correlated with each other to develop continuous streamflow data from 1916 to 1964 for Long River and from 1913 to 1964 for Crater Creek. Tables 15 and 16 contain this data. Correlation procedures

described in Leo R. Beards' "Statistical Methods in Hydrology" were used. Details of the methods used in correlating the flows of Dorothy Creek, Long River and Crater Creek are presented in Design Memorandum No. 1, Hydrology. Use of these flows to develop simulated monthly flows is described in detail in Design Memorandum No. 7, main report.

3-03 SIMULATED MONTHLY FLOWS

The present practice in design of water resource projects includes the routing of monthly streamflows based on past records through project facilities in order to determine project accomplishments. A system of synthesizing monthly runoff is used to overcome some of the deficiencies in the present practice of assuming that historical runoff will be repeated. Synthesizing permits a reasonable mathematical determination of expected project benefits insofar as hydrologic factors are concerned. In order to examine the project under more realistic assumptions, forty 50-year periods of monthly records were generated synthetically using the procedures outlined in "Technical Bulletin No. 1, Simulation of Monthly Runoff" published by the Hydrologic Engineering Center of the U. S. Army Corps of Engineers, Sacramento, California, in November 1964. The project was then examined using higher than and lower than normal flows for the next 50-year period. The results of this examination show that should the next 50 years be considerably wetter than normal, the effect on prime power would be negligible. However, should the next 50 years be considerably dryer than the previous 50 years, the effect would be a reduction of up to 3 percent in the amount of prime power that could be generated and that the project could actually go dry if the prime capability was maintained. A frequency curve was derived using the values of the developed forty 50-year periods

and is shown on Chart 4. As may be seen from this chart, there is a 90 percent chance that the average annual volume in acre-feet for the next 50 years will be in the range of 316,500 to 330,400 acre-feet.

3-04 SEDIMENTATION AND EVAPORATION:

a. There are no data presently available concerning the actual sediment loads carried by streams tributary to the Long Lake reservoir. Evaporation studies are detailed in Design Memorandum No. 1 but show no significant losses. These streams are predominately glacial and as such carry significant suspended sediment and bed loads. Measurements of the amount of sediments suspended in the lake were made in March and July of 1965. These measurements indicate an average sediment concentration near the outflow of about 5 parts per million.

b. Because of the lack of actual sediment inflow rates, it is not possible to compute the annual storage depletion by direct methods; however, a reasonable estimate may be made by indirect methods. The Tonsina River, located in the Copper River Basin, has a drainage area with characteristics similar to Long Lake. Forty-seven suspended sediment measurements made during the last few years indicate an average suspended sediment concentration of 113 parts per million. Subtracting the 5 parts per million measured at the outflow and applying this ratio to Long Lakes annual inflow of 324,300 acre-feet yields an annual suspended sediment inflow of 35 acre-feet per year. No data are available concerning movement as bed load; however, for the purpose of this study an average annual contribution of 15 acre-feet has been assumed. Observation of the uniformity of the suspended sediment concentration through the lake indicate that almost all of the inflowing sediments are deposited shortly after reaching the lake water; therefore, it may be

described in Leo R. Beards' "Statistical Methods in Hydrology" were used. Details of the methods used in correlating the flows of Dorothy Creek, Long River and Crater Creek are presented in Design Memorandum No. 1, Hydrology. Use of these flows to develop simulated monthly flows is described in detail in Design Memorandum No. 7, main report.

3-03 SIMULATED MONTHLY FLOWS

The present practice in design of water resource projects includes the routing of monthly streamflows based on past records through project facilities in order to determine project accomplishments. A system of synthesizing monthly runoff is used to overcome some of the deficiencies in the present practice of assuming that historical runoff will be repeated. Synthesizing permits a reasonable mathematical determination of expected project benefits insofar as hydrologic factors are concerned. In order to examine the project under more realistic assumptions, forty 50-year periods of monthly records were generated synthetically using the procedures outlined in "Technical Bulletin No. 1, Simulation of Monthly Runoff" published by the Hydrologic Engineering Center of the U. S. Army Corps of Engineers, Sacramento, California, in November 1964. The project was then examined using higher than and lower than normal flows for the next 50-year period. The results of this examination show that should the next 50 years be considerably wetter than normal, the effect on prime power would be negligible. However, should the next 50 years be considerably dryer than the previous 50 years, the effect would be a reduction of up to 3 percent in the amount of prime power that could be generated and that the project could actually go dry if the prime capability was maintained. A frequency curve was derived using the values of the developed forty 50-year periods

and is shown on Chart 4. As may be seen from this chart, there is a 90 percent chance that the average annual volume in acre-feet for the next 50 years will be in the range of 316,500 to 330,400 acre-feet.

3-04 SEDIMENTATION AND EVAPORATION:

a. There are no data presently available concerning the actual sediment loads carried by streams tributary to the Long Lake reservoir. Evaporation studies are detailed in Design Memorandum No. 1 but show no significant losses. These streams are predominately glacial and as such carry significant suspended sediment and bed loads. Measurements of the amount of sediments suspended in the lake were made in March and July of 1965. These measurements indicate an average sediment concentration near the outflow of about 5 parts per million.

b. Because of the lack of actual sediment inflow rates, it is not possible to compute the annual storage depletion by direct methods; however, a reasonable estimate may be made by indirect methods. The Tonsina River, located in the Copper River Basin, has a drainage area with characteristics similar to Long Lake. Forty-seven suspended sediment measurements made during the last few years indicate an average suspended sediment concentration of 113 parts per million. Subtracting the 5 parts per million measured at the outflow and applying this ratio to Long Lakes annual inflow of 324,300 acre-feet yields an annual suspended sediment inflow of 35 acre-feet per year. No data are available concerning movement as bed load; however, for the purpose of this study an average annual contribution of 15 acre-feet has been assumed. Observation of the uniformity of the suspended sediment concentration through the lake indicate that almost all of the inflowing sediments are deposited shortly after reaching the lake water; therefore, it may be

assumed that all of the 50 acre-feet per year of storage depletion will occur in live storage.

3-05 CRITICAL PERIODS:

a. General - For the period of record flows the critical periods corresponded very closely with those presented in the authorizing document. However, higher demand required a slightly longer refilling time after minimum pool. The critical period for Long Lake extends from November 2014 to September 2031 which corresponds to period of record years 1949 to 1963 and a recycle period of 1916 to 1918. A proportionately smaller volume of storage in Crater Lake causes extensive pool fluctuations throughout the period of study with the pool approaching minimum several times. The critical period for Crater Lake extended from November 1986 to August 1991 or the water year equivalent of 1919 to 1924.

b. Synthetic Flows - Critical periods for the high and mean synthetic flow patterns did not show significant difference from the period of record flows; however, synthetic low flows showed a critical period much more severe than the period of record. Since the critical period of the period of record is normally used for determination of dependable capacity and primary energy the same procedure was used in this study. The significance of the longer critical period is discussed in paragraph 6-02.

3-06 COST OF ALTERNATIVE POWER:

a. General - The Federal Power Commission provided alternative power values for computation of both benefits and project scoping. Their letters of 19 Feb 65 and 25 Feb 64 are included as Exhibits 3 and 5.

b. Energy - The value of hydroelectric energy at market in Juneau, Alaska, based on cost of alternative power produced at a Juneau steam-

electric plant is estimated to be 6.91 mills per kilowatt-hour. This figure was used in both the benefit and scoping computations developed in Design Memorandum No. 3.

c. Capacity - The computation of benefits as presented herein used a value of $65.11 per kilowatt-year. However, the scoping analysis presented in Design Memorandum No. 3 used a capacity value of $29.11 per kilowatt year.

SECTION 4

POWER INSTALLATION STUDIES

SECTION 4 - POWER STUDIES

4-01 INTRODUCTION

a. Since the original 1958 feasibility study by the U. S. Bureau of Reclamation, several major changes have called for reanalysis. Prior to Congressional authorization, the Georgia-Pacific Alaska Company relinquished their rights to development of a newsprint mill in the area, causing a reanalysis of the project in 1961. During the above reanalysis drilling was initiated to determine the feasibility of a dam at Long Lake outlets. Time limitations precluded complete examination and the project was authorized without a dam at Long Lake. Subsequent Corps of Engineer studies prior to final construction considered reduction in unit size to provide firmer reserves combining the reservoirs by raising Long Lake, updating the area's power demand and feasibility of a dam at the Long Lake outlet. Results presented in Design Memorandum No. 3 recommend an eighty foot dam at Long Lake, three equal size units and two stage construction.

b. The information and data presented in this appendix are the results of detailed analyses of the recommended plan. An electronic computer was used to examine maximum project potential, revised tailwater elevations, rule curve operation, synthetic flow patterns, updated load requirements, updated area-storage curves and revised efficiencies.

4-02 SCOPE

a. Preliminary studies were made to examine various alternatives including several pool elevations for both Long and Crater Lakes and possible combined operations by lowering Crater Lake while raising Long Lake. Other variables considered in the preliminary studies were energy requirements, load growth, flow patterns and construction sequences. In

all, eleven alternative plans or a minimum of 33 different conditions were examined to determine benefit-cost comparisons and to provide the basis for the incremental scoping analysis presented in Design Memorandum No. 3.

b. Detailed studies of Long Lake at elevation 895 and further studies of Crater Lake at elevation 1022 are presented herein. The more detailed studies were conducted to determine optimum primary and secondary potential, establish unit design criteria and determine operational limitations. The studies and analyses presented herein considered the latest growth rate forecast (Exhibit 4 and Table 3), synthetic flows and the variable conditions previously mentioned.

4-03 PRELIMINARY STUDIES:

a. Studies were made for eleven alternative plans and were complete enough to provide unit design criteria for estimating unit sizes and costs. The alternatives studied covered possible operation of Long Lake between elevations 815 and 1022, Crater Lake between elevations 1022 and 1220 and the two lakes as a single reservoir between elevations 860 and 1022. Results of preliminary studies are shown on Plates 20 to 22 and listed on Tables 12 and 13.

b. Long Lake was examined at four maximum pool elevations (815, 900, 950 and 1020) with energy production loading that varied from 192.6 million kilowatt-hours per year to 263.0 million kilowatt-hours per year. The rise in pool elevation allowed an increase in active storage from 193,800 acre-feet to a maximum of 350,000 acre-feet at the upper pool. The availability of this increase in storage allowed an average annual reduction in wasted water from 7,000 acre-feet per year to 1,850 acre-feet per year. For maximum pool elevation of 950, the minimum pool was 797 or 18 feet below the

natural lake elevation. In this case only a slight lowering of the lake would have sufficed for building the intake structure. Design head for the units varied from approximately 768 up to 973 at the upper pool. Tables 12 and 13 list other data.

c. Crater Lake was examined at three maximum pool elevations (1022, 1122 and 1222) with energy production that varied from 104.8 million kilowatt-hours per year to 133.0 million kilowatt-hours per year. Wasted water or water not usable for power production was reduced from an annual average of 4910 acre-feet at elevation 1022 to an average of 1500 acre-feet at elevation 1222. Due to more efficient water use, the maximum drawdown was reduced from 175 feet at the lower elevation to 115 feet at elevation 1222. Tables 12 and 13 list other data.

d. The two lakes operating as a common reservoir were examined at pool elevations of 860, 900, 950 and 1020. The primary energy production varied from 294.2 million kilowatt-hours per year to a maximum of 381.3 million kilowatt-hours per year. Active storage increased from 264,000 acre-feet at elevation 860 to 348,000 acre-feet at elevation 1022. An overall summary of results (Table 13) lists the selected studies and also compares the totals of the project document plan with the combined operation at elevation 860. The decrease in waste flow of an average annual volume of 7,400 acre-feet is realized by combined operation, and is reflected in increased production of 14.2 million kilowatt-hours per year of prime energy. It should be noted that under no condition of combined operation would it be possible to lower the Crater Lake intake structure much below elevation 750 because of reduction in storage and possible future sedimentation difficulties. A small increment of storage would therefore be dead

storage and would not be available for combined pool operation.

4-04 FINAL STUDIES:

a. Final studies were made to determine the optimum primary power potential of the project. With the aid of an electronic computer, synthetic flows were developed to study the effect of higher and lower than period of record flows during the critical periods. Final studies verified the primary energy capability, size and number of units and powerhouse criteria. Samples of computations are illustrated on Plates 6 through 14. Annual summaries are shown on Tables 6 through 9.

b. Long Lake was studied with a dam to elevation 895. A firm energy output of 225 million kilowatt-hours per year and a nonfirm output of 10.8 million kilowatt-hours per year was the energy potential resulting from the studies. With the dam, Long Lake will provide an active storage of 252,000 acre-feet with the pool fluctuating from elevation 895 to a minimum elevation of 720. On the basis of two 20,300 kilowatt units for the Long Lake phase and the power forecast for the Juneau area, studies indicated that the Long Lake phase of the project should go on line by 1970 to meet the demand. Growth studies showed that the Long Lake phase can be scheduled to meet demand until 1979 thereby allowing deferment of the construction costs of the Crater Lake phase. In the final studies, a rule curve analysis (Charts 1 & 2) was devised to provide optimum production of nonfirm power by allowing the pools to be drawn to predetermined elevations during the low flow winter months.

c. Using the natural lake elevation as the normal pool, the Crater Lake phase of the project can provide a firm energy output of 106 million kilowatt-hours per year and a nonfirm energy output of 12.4 million

kilowatt-hours per year. The pool will fluctuate between elevations 1022 and 828 providing an active storage of 81,000 acre-feet. If at a future date, a dam at the outlet of Crater Lake is found to be feasible, a reservoir would provide desirable additional storage and a greater firm energy output would be realized. Rule curve analysis allows optimum use of the nonfirm power by allowing the pools to be drawn down to predetermined elevations during the low flow winter months. The results of rule curve operation indicate that Crater Lake can be drawn down as low as elevation 800; however, since physical conditions may dictate the elevation of the intake invert, the minimum used in determining energy potential was established without application of the rule curve.

4-05 OPERATING CONDITIONS AND BASIC CRITERIA:

a. Reservoir Requirements - The Snettisham project is unique in its remote location. It will be used for the production of power only. The normal allowance for fish, flood control, navigation, irrigation or water supply for downstream requirements have not been considered in its justification due to this remoteness. Operation of the reservoirs will be determined by the load shape, demand and water supply only.

b. All available historical runoff records were used in the regulation and power demand studies. Extensive correlation was also made with Dorothy Creek, a similar stream and located near the proposed project. A maximum of 49 years of record were available for study at this time. For Long Lake, the period from 1916 through 1963 was used, while for Crater Lake, the period from 1913 through 1963 was used. For examining the lakes operating as a combined unit, the 1916 through 1963 flow records were combined resulting in a 46-year period for the combined lakes. In

conducting the final regulation and power studies, it was assumed that the first year of water record would be considered as 1980 and the studies ran from 1980. Tidal fluctuations in the project are extreme, with a maximum range of 28 feet. The project document assumed a uniform tailwater elevation of 2 feet. The present studies assumed an outlet sill elevation of -1.0 msl and average tide conditions.

c. With two exceptions, terms used in this power appendix are based upon definitions as found in the "Glossary of Terms" 1949 edition, compiled under the supervision of the Federal Power Commission. The two exceptions are the terms "Spill" and "Waste" which are defined as follows: "Spill" is the discharge passed through the turbines for the production of secondary energy. "Waste" is the discharge over the spillway which cannot be used for production of power due to lack of machine capacity.

4-06 POWER VALUES AND TRANSMISSION LOSSES:

a. Power values were furnished by the Federal Power Commission in their letter of 25 February 1964 (Exhibit 5) and were based on a privately financed 49,500 kilowatt oil-fired steam plant located at tidewater in Juneau. The value of power was determined to be $65.11 per kilowatt-year for net dependable capacity and 6.91 mills per kilowatt-hour for net primary energy.

b. Transmission losses from the project to the Juneau area were assumed to be 6 percent overall.

4-07 ENERGY DETERMINATIONS:

a. <u>General</u> - The basis for determination of power demand or output was the estimated total requirement of the Juneau area, including all line losses and other losses attributal to regular power use. Studies during

the 50-year period were based upon a constant demand throughout the period of study and it was assumed that machine capacity would be provided to meet the demand both base and peaking.

b. Regulation Studies - The use of a special computer program facilitated examination of many different alternatives. Different power demands for regulation as well as different pool elevations for each alternative were considered. The program takes into consideration variation in head, operational efficiencies of the units, varying hydraulic losses, rule curve operation and discriminates between usable spill and waste dependent upon the assumed machine capacity of the alternative being studied. In order to initiate a study of any one condition, several preliminary computations and basic assumptions were made as follows:

(1) It was assumed that the pool was full in late summer but by January 1 was drawn down by a volume determined from the preliminary computations.

(2) A uniform annual energy load was determined using mass curves, assumed water losses, assumed average head, and the established average annual inflow. A minimum of 3 annual energy loads was used to develop curves for each condition being studied.

(3) The annual energy load was then distributed by months as listed in Table 4.

(4) Installed capacity was determined as outlined in 4-07g.

(5) Machine capacity at maximum pool was determined assuming 15 percent overload at the appropriate reduced efficiency.

(6) A minimum allowable pool elevation was chosen at approximately 70 percent of design head. For the Snettisham project, this represented a

drawdown greater than 200 feet in all cases. None of the alternatives studied could be drawn down this far and recover full pool without reduction in demand.

c. Efficiencies used at various pool elevations were based on EM 1110-2-1701 and USBR Engineering Monograph No. 20. Generator efficiency was considered to be 95 percent while turbine efficiency varied from below 80 percent to a maximum of 91.4 percent, depending upon the operational range or percent of design head. Hydraulic efficiency was based on percent of gross head and varied from 96 percent to 98 percent of design head. Plate No. 17 shows the various efficiencies. Overall efficiency varies from 76.0 to 84.8 percent depending upon percent of design head.

The basic power formula is: $KW = \frac{Q\ H\ E_o}{11.8}$

Where KW = kilowatts

Q = flow in cfs

H = gross head (difference between pool and tailwater elevations)

E_o = overall efficiency

Dividing efficiencies by the constant (11.8) the formula reduces to: $KW = C\ Q\ H$

Where C varies from 0.065 to 0.0718 and is dependent upon percent of design head as shown on Plate 17.

d. Power Demand - Power demand was based on preliminary estimates of the potential possible at each pool elevation for each alternative considered. For preliminary studies a minimum of three different loadings or power demand sequences were placed on each pool elevation and each regulation run. Plates 20 through 22 show typical results and the curves resulting

from plotting various items such as minimum pool elevation, maximum drawdown, total potential revenue, average pool elevation and others for the various conditions and alternatives.

e. Load Factors - Load factors used in these studies were the same as presented in the project document. Information received from the Juneau area during the last 3 years indicates that the load factor continues to be near the 55 percent previously established.

f. Dependable Capacity - The dependable capacity for each alternative studied was based upon the minimum pool reached in each regulation study and considered the reduction in overall plant efficiency but allowed operation up to full gate. Tidal effect was considered during minimum pool conditions; however, no significant reduction in dependable capacity is expected due to conservative estimates of hydraulic losses used in the studies, excess capacity designed into the unit and the nominal period of time that such conditions would prevail.

g. Installed Capacity - The machine capability or installed capacity for each alternative studied was based on the annual load shape and the load factor. The capabilities used for preliminary studies are not necessarily the final choice of installed capacity for the project. They were used only for comparative purposes.

Installed capacity was computed as follows:

$$KW = \frac{\text{Annual load}}{8760 \text{x} 0.55 \text{x} 115}$$

Total machine capability was determined by using the following formula:

$$KW = \frac{\text{Annual load}}{8760 \times 0.55}$$

Where Annual load = number of KWH required per year

115 = allowable machine loading in percent

8760 = number of hours per year

0.55 = assumed load factor

h. Electronic Computer Use - A program was developed for use with an electronic computer and was utilized in making all basic power output determinations for the range of development conditions covered. Use of this computer program permits simulation of actual powerplant operation on an average basis. Various loads were placed in the computer as were inflows for the period of record. The machine computes outflow, average head, pool elevations, end of the month storage, primary energy, secondary energy and waste. The program is designed to simulate monthly operation of up to 10 projects. To obtain secondary power during the winter operation, a rule curve routine was developed. Pilot studies were used in the preliminary investigations and to arrive at the Long Lake dam height elevation of 895. Subsequent modifications have produced the final studies as listed in Tables 5 through 9.

4-08 INSTALLATION SCHEDULE:

The total project has been scheduled to meet the power forecast as determined in the Bureau of Reclamation forecast (Table 3) and yet defer the Crater Lake phase cost for several years. This schedule will place the first unit of the Long Lake phase on line by 1970 in time to meet the increasing power demand of the Juneau area. The second unit of Long Lake must be on line no later than 1972. The Long Lake phase will then meet demand until 1979 when the Crater Lake phase must be on line.

4-09 SNETTISHAM UNIT CRITERIA:

The basic decision to make all unit sizes equal (Exhibit 6) determined

the unit size to be installed at 20,300 KW. This size will give the unit a dependable capacity with overload of 23,350 KW. In the case of Long Lake, the maximum pool elevation will be 895, the minimum pool elevation 720 and with an average pool elevation 843. Maximum discharge through the Long Lake phase will be 980 cfs. For Crater Lake, the maximum pool elevation is 1022, the minimum pool elevation is 828 and with an average pool elevation 967. Maximum discharge through the Crater Lake phase under normal operating conditions is 410 cfs. Minimum pools may be dependent upon the physical limitations of the tunnel intake structures. Provisions of interconnections to permit inspection of either penstock while two units remain in operation requires a maximum discharge of 530 cfs from Crater Lake. This flow would be required only for peaking (early summer peak - 34,000 KW) during closure of Long Lake penstock. Although the tidal fluctuation in Speel Inlet is about 28 feet, a minimum tailwater has been established by placing a tailrace sill at elevation -1.0 msl. Maximum tailwater elevation corresponds to maximum tide or about 16.0 feet msl. The above unit criteria, as summarized in Table 11, are based upon maximum capability derived from FPC criteria and actual load shapes shown in Table 4.

4-10 PROJECT COSTS:

Total cost of the recommended project plan is estimated at $59,760,000. The first phase, development of Long Lake, is estimated to cost $45,338,000. The second phase, development of Crater Lake, is estimated to cost $14,422,000. Based on data furnished by the Bureau of Reclamation, annual operation, maintenance and interim replacement costs for the Long Lake phase are estimated to total $475,000 and it is estimated that ultimate addition of the Crater Lake phase will increase this requirement by $8,000 for a project total

O M & R cost of $483,000 per year. Computations are based on an 8-year construction period for the Long Lake phase and a 7-year construction period for the Crater Lake phase. Present projections of power load growth in the area show that power from the Crater Lake phase of the project will be needed seven years after construction of the Long Lake phase is completed. Costs of the Crater Lake phase have been present-worthed accordingly. An interest rate of 3-1/8 percent has been used to establish the capital investment and to compute the annual costs of interest and amortizations. On these bases the average annual cost of the project for a 50-year life has been computed as follows:

Long Lake Phase (Elev. 895)

Construction Cost	$40,300,000
Interest During Construction	
(3-1/8 percent - 8 years)	5,037,000
Total Investment	$45,337,000
Annual Costs	
Interest and Amortization	
(45,337,000 x 0.03979)	$ 1,804,000
Operation, Maintenance and Replacements	475,000
Average Annual Costs	$ 2,279,000

Crater Lake Phase (Elev. 1022)

Construction Cost	$13,000,000
Interest During Construction	
(3-1/8 percent - 7 years)	1,422,000
Total Investment	$14,422,000
Annual Costs	

Interest and Amortization	
(14,422,000 x 0.03979)	$ 574,000
Operation, Maintenance and Replacements	8,000
Average Annual Costs	$ 582,000

Average Annual Costs for Complete Project

Long Lake	$2,279,000
Crater Lake Present-Worthed to Completion	
Date of Long Lake (582,000 x 0.80622)	469,000
Total Annual Costs (50-year life)	$2,748,000

Application of the same procedures to computations based on a 100-year project life results in computed average annual costs, as follows:

Long Lake Phase	$1,966,000
Crater Lake Phase	387,000
Complete Project	$2,347,000

4-11 POWER BENEFITS:

The Snettisham project has the sole purpose of producing power for the Juneau area. All benefit determinations and comparisons reflect credit for prime power only. Energy and capacity creditable to this specific power plant during its economic life were based on criteria shown in paragraph 4.06 and as furnished by the Federal Power Commission in their letter of 25 February 1964. Based on a privately-financed, 49,500 KW, oil-fired steam plant, the at-market value of power was determined to be $65.11 per kilowatt-year for net dependable capacity and 6.91 mills per kilowatt-hour for net primary energy. At-site dependable capacity for the Long Lake phase of the recommended plan was determined to be 46,700 kilowatts. The decision to make all generating units the same size results in provision

of 23,350 kilowatts of at-site dependable capacity for the Crater Lake phase. At-site primary energy was computed to be 225,000,000 kilowatt-hours annually for Long Lake and 106,000,000 kilowatt-hours annually for Crater Lake. To derive net or at-market values, station use and transmission line losses were assumed to total 6 percent for both capacity and energy. Benefits were not assigned for secondary energy. Benefit computations for the recommended project plan are summarized as follows:

ANNUAL BENEFITS

Long Lake @ 895		
Dependable Capacity Value (46,700 x 65.11 x 0.94)	=	$2,858,000
Energy Value (225,000,000 x 0.00691 x 0.94)	=	1,461,000
Annual Benefits		$4,319,000
Crater Lake @ 1022		
Dependable Capacity Value (23,350 x 65.11 x 0.94)	=	$1,429,000
Energy Value (106,000,000 x 0.00691 x 0.94)	=	689,000
Annual Benefits		$2,118,000
Complete Project		
Long Lake	=	$4,319,000
Crater Lake, present worthed to completion date of Long Lake ($2,109,000 x 0.80622)	=	1,707,000
Total Average Annual Benefits		$6,026,000

4-12 ECONOMIC ANALYSIS:

The economic relationship resulting from cost and benefit evaluation are summarized as follows:

	50-Year Life			100-Year Life		
Project Phase	Ann. Cost	Ann. Benefit	B/C	Ann. Cost	Ann. Benefit	B/C
Long Lake	$2,279,000	$4,319,000	1.90	$1,966,000	$4,319,000	2.20
Complete Project	2,748,000	$6,029,000	2.19	2,347,000	$6,029,000	2.57

The above analysis did not recognize the value of secondary energy; therefore, benefits are lower than maximum. Assuming the minimum secondary energy production, as listed in Tables 6 through 9, average annual benefits and B/C ratios would then be:

	50-Year Life		100-Year Life	
Project Phase	Annual Benefit	B/C	Annual Benefit	B/C
Long Lake	$4,365,000	1.92	$4,365,000	2.22
Complete Project	$6,119,000	2.23	$6,119,000	2.61

The value of secondary energy is assumed to be 5 mills/KWH. Cost vs benefit curves are relatively flat in the range of dam height proposed. An incremental scoping analysis was developed in Design Memorandum No. 3 to determine the economical dam height. Federally financed power values of $29.29/KW for capacity and $0.00691/KWH for primary energy were used in the scoping analysis. In making the economic analysis both 50-year and 100-year life was computed.

4-13 DISCUSSION:

During the study period new load growth rates, the decision to make equal sized units and greater refinement of the computer studies have resulted in a 3-unit powerplant with a dependable capacity of 70,000 KW capable of delivering 331 million kilowatt-hours of firm power and about 20.8 million kilowatt-hours of secondary energy at site annually. An

additional feature of rule curve operation was added to the computer program to provide the most efficient use of the secondary energy by allowing the pools to be drawn to predetermined elevations throughout the year. The two-stage development is scheduled to place an initial unit on line at the end of 1969 and a second unit on line by 1972. The second phase will place the third unit on line in 1980 and demand on the project is expected to reach full capacity in 1983.

SECTION 5

POWER FACILITIES

SECTION 5 - POWER FACILITIES

5-01 GENERAL

Preparation of powerhouse plans and estimates in this appendix to the General Design Memorandum and the following text material concerning the power facilities has been accomplished by the HydroElectric Design Branch of the North Pacific Division. Two proposed plans are presented herein, the conventional indoor-type powerhouse and an underground plant. These plans cannot be considered final but do afford a sound basis for cost determination between the two types of plants. For cost comparison purposes the plants were compared for their ultimate capacity of three units with a vertical Francis-type turbine. The number of units and kilowatt capacity of initial and ultimate installations are considered firm; however, further study will be required to select final type, size and setting of turbines and unit spacing. Location of the powerplant with respect to other features of the project is shown on Plate 1.

5-02 POWERHOUSE

a. Conventional The powerhouse will be reinforced concrete indoor type structure equipped with a 75-ton bridge crane to serve for erection and maintenance of the units. The powerhouse initially will consist of two generator bays, erection bay and skeleton bay, all complete with superstructure. Units one and two will be served by the penstock from Long Lake and unit three will be served by the penstock from Crater Lake. The erection bay is of sufficient width and length to provide adequate space for an unloading area and a rotor erection area at elevation 23.0. The generator bay is of sufficient width and length to adequately house the generators and turbines and provide necessary clearances. A 3-ton monorail attached to the

downstream exterior face of the powerhouse wall, complete with lifting beam and sling, will be used for handling the draft tube bulkhead. Space allocations and location of powerhouse equipment are shown on Plates 23 through 27.

b. Underground Space allocation and location of powerhouse equipment for the underground plant are shown on Plates 28 through 32. The generator room width was increased to include the draft tube slots and spherical valves so that the valves and draft tube bulkheads could be handled by the bridge crane. The auxiliary and control area shown in the conventional plant to be upstream from the generator room was moved to the erection bay in the underground plant. This was done to reduce the width of the cavity excavated for the underground plant. No provisions will be made in the underground plant for a maintenance area or electrical shop. The portions of the wall above the erection floor level and balcony level will be exposed rock, which in the event of loose rock, will be covered with chain link fabric. No structural reinforcement of the roof is contemplated, however a metal arch roof, accoustically treated, will be used for protection from falling of rock spalls and moisture. Access to the underground plant will be by tunnel approximately 17 feet wide and 15 feet high. Ventilation air will be taken from the powerhouse access tunnel. Exhaust air will be carried to atmosphere either by a duct within the powerhouse access tunnel or a separate exhaust tunnel.

5-03 TURBINES, GENERATORS AND ELECTRICAL EQUIPMENT

a. Criteria In accordance with the results of studies presented in this appendix each unit will be designed to provide a dependable capacity of 23,350 KW. The generators will be designed to produce this load at 115

percent generator nameplate rating at 0.9 power factor. Other criteria are listed in Table 11.

b. <u>Turbines</u> The turbines will be of the vertical shaft, Francis-type with steel spiral cases and concrete elbow draft tubes. Each unit will be designed to produce a guaranteed output of 32,000 HP (23,350 KW) at minimum pool elevation. Best efficiency will be achieved at the average pool elevation. Guard valves will be provided upstream from each unit for emergency shutdown and maintenance. A valved connection will be provided between the Crater Lake unit and the adjacent Long Lake unit to assure the operation of two units when the Long Lake waterway is shut down for inspection or maintenance. Preliminary studies indicate that pressure regulators are required for the conventional powerhouse to provide acceptable speed regulation without the need for abnormal amounts of generator WR^2. The cost of the regulators has been included in the estimate for the conventional plant. The final selection of the type and size of guard valves and pressure regulators will be the subject of further study in the Powerhouse Preliminary Design Report.

c. <u>Electrical Features-Conventional Plant</u> Subject to completion of detailed studies, the anticipated layout of the electrical features of the conventional powerhouse will conform to normal accepted practice for such plants. A common auxiliary and control area is planned at the turbine floor elevation upstream from the units, where station switchgear, switchboards, control equipment and other electrical equipment will be located as indicated on Plate 25. The vertical generators will be rated 22,600 KVA, 0.9 PF, 13.8 KV at 60°C. temperature rise with capability of operating continuously at 115 percent rated KVA. Detailed electrical and mechanical

characteristics will be as determined by additional studies; however, higher than normal WR^2 will probably be required because of the long penstock. Individual three phase power transformers for each unit are presently planned to insure having one unit available initially for service at all times. These transformers will be rated 26,000 KVA, 13.8-138 KV Gnd Y, type FOA, and are tentatively planned to be located at a 138 KV switchyard near the powerhouse. Low voltage connections would be via aerial 15 KV cables from the powerhouse. Design of the control features will be as required for eventual complete remote control of the plant from Juneau, Alaska, via carrier current. Anticipated station service power scheme is a 13.8 KV-480 volt, double ended substation supplied from the terminals of the two generators with an independently driven emergency generator capable of supplying essential loads only.

d. Electrical Features-Underground Plant - The electrical features of the underground plant are essentially the same as the conventional plant. The location of this equipment will be as indicated on Plate 31. The increased distance from the powerhouse to the switchyard may result in the transformers being located closer to the generators with 138 KV cable connections to the switchyard depending on the results of future studies.

5-04 POWER PENSTOCKS

Although the data presented in Snettisham Project Design Memorandum No. 3 indicates diameters of 6 and 7 feet for the Crater Lake and Long Lake penstocks respectively, future studies will be presented in the Preliminary Design Report on the Powerhouse to justify the most economical size.

SECTION 6

POWER OUTPUT

&

UTILIZATION

SECTION 6 - POWER OUTPUT AND UTILIZATION

6-01 POWER POTENTIAL:

The Long Lake and Crater Lake phases of the Snettisham project are designed to operate at maximum gross heads of 895 and 1022 feet, respectively, with average annual inflows of 448 cfs and 203 cfs. The project will provide potential energy of about 331 million kilowatt-hours annually depending upon operation. Utilization of potential generation will be solely in the Juneau area. Final studies indicate that maximum revenue will be derived from the most efficient production of secondary energy after the project reaches maximum capabilities. Integrated operation of this system may find that the Crater Lake phase with its greater waste should be operated primarily as a base load plant and Long Lake with its greater storage capabilities be operated as a peaking plant. Area power requirements and resource studies indicate that initial generation will be usable as soon as it can be made available.

6-02 CONDITIONS OF OPERATION:

a. General - Since power production is the sole objective of the Snettisham project, it will be operated as efficiently as possible while producing a maximum number of saleable KWH. Operation or reservoir regulation will be characterized by two general conditions; one will be the winter low stream flow season of October through May, while the other will cover the summer and fall high runoff season of May to October. Maximum energy output and minimum waste will be dependent upon forecasting ability and operational procedures that combine the optimum use of available water and machines. Operational experience in conjunction with improved data accumulation will result in improved rule curves and regulation criteria.

b. Rule Curve Operation - Examination of regulation studies provided monthly minimum pool allowances which were used to develop rule curves (Charts 1 and 2). With rule curve operation, secondary energy can be produced throughout the year whenever surplus water is available. Use of these preliminary rule curves increased production of secondary energy while reducing waste flow. The refined rule curves that will be developed will result in optimum use of available water. It must be assumed that plant factors will not be the same as the Juneau load factor or even show similarity between Long and Crater Lake operations.

c. Synthetic Flows - Synthetic flows were developed and compared to period of record flows in order to determine the probability of major changes in critical periods. The studies of high and mean synthetic flows indicated only minor differences in inflow patterns and no change in energy production potential. On the other hand the study of low synthetic flows indicated that there is a fifty percent chance of experiencing a more severe critical period than occurred during the period of record. Although the critical period may be more severe, the degree of severity is important since a three percent reduction in primary energy would have an occurrence probability of only one in five hundred. Therefore, even though a more severe critical period may occur in the next fifty years, the possibility of significant reduction in primary energy is minimal and of less importance than other factors at this time.

d. Low Stream Flow Season - The period of low inflow to both Long and Crater Lakes occurs during the winter months, generally October to May. Although heavy precipitation, in the form of rain and snow, occurs during this period, it is retained in the snowpack and very little runoff is

available for inflow. Since this is also the period of greatest power demand, the pools will invariably be drawn down with minimum pool occurring in early May. It is during this period that accurate forecasting and judicious production of secondary energy will reduce or eliminate waste during the summer months.

e. High Stream Flow Season - During the summer months of May through October, the runoff not only includes snowmelt but relatively heavy direct precipitation in summer and fall rains. During this period the demand is at its annual minimum and the pools will refill. Optimum operation during this period would be to fill the pools without wasting water.

f. Growth Years - During the anticipated thirteen-year growth period, there will be excess water available for production of secondary energy; however, demand is not expected to be present. The resulting apparent waste was not used in computing the average annual waste listed for either Long or Crater Lakes. The fact that waste is inevitable makes both hydraulic or electrical losses meaningless during the growth period.

6-03 POWER PRODUCTION:

The detail studies have shown that optimum economical development of the available power potential of the Snettisham project required that Long and Crater Lakes be operated as separate reservoirs connected to a common powerhouse by pressure tunnels and penstocks. Generally water from the Long Lake phase will be used to operate two units; however, provision has been made to operate two units with water from Crater Lake during periodic inspection of the Long Lake tunnel and penstock. Both phases will be operated to provide maximum firm energy and to produce secondary energy with the remaining flow up to unit capacity. Operation of the project will provide

basic criteria to further refine the rule curves and hence provide optimum operation.

EXHIBITS

COPY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
P.O. Box 7002
Anchorage, Alaska 99501

ADDRESS REPLY TO
THE DISTRICT ENGINEER
(NOT TO INDIVIDUALS)

REFER TO FILE NO.
NPAEN-PR-R

31 January 1964

Mr. M. Boyd Austin
Regional Director
Federal Power Commission
555 Battery Street
Room 415
San Francisco, California 94111

Dear Mr. Austin:

This office is presently preparing the General Design Memorandums for the Snettisham Project near Juneau, Alaska, (House Document No. 40, 87th Congress). In connection with the Hydropower Capacity studies of this memorandum, it would be appreciated if this office could be apprised of your opinions, suggestions and/or comments regarding the following major questions.

a. What sort of reserve would be required for an isolated system of this type?

b. What portion of the available prime power could be considered as firm with no reserve and a single line (115,000 v, 38.7 miles) from site to market, especially in view of the terrain in the Juneau area?

c. What would be the alternative value of power for a project of this size in this area?

Sincerely yours,

/s/t/K. T. SAWYER
Colonel, Corps of Engineers
District Engineer

EXHIBIT 1.1

FEDERAL POWER COMMISSION
REGIONAL OFFICE
555 BATTERY STREET, ROOM 415
SAN FRANCISCO ~~11~~, CALIF. 94111

February 16, 1965

AIRMAIL

Colonel Clare F. Farley
District Engineer
U.S. Army Engineer District, Alaska
Corps of Engineers
Post Office Box 7002
Anchorage, Alaska 99501

Dear Colonel Farley:

Mr. Mark Nelson of your division office in Portland has discussed with me the implications of our letter of February 25, 1964, concerning the Snettisham Project, and has asked that I provide some amplification of the comments in line with our telephone conversations.

The statements made in our letter of February 25, 1964, concerning the maintenance of firm capability are, we think, self-evident and need no further explanation as such. However, the buyer and seller may agree on some measure of reliability which is less than 100 percent firm. Thus, the buyer may be willing to drop some of his load in case of an outage that is not covered by reserves. In some instances, a load may be served which is not greatly inconvenienced by an interruption of power supply. At other times, there will be inconvenience, but the purchaser of service takes a calculated risk that it will not happen, in order to obtain service at a lower cost. Such conditions of risk and price are subject to some negotiation between buyer and seller, and as such are not of direct concern to the Federal Power Commission so long as the negotiations are carried on with the full knowledge of both parties as to the risks involved and savings resulting therefrom.

These statements would also apply to the transmission of the power to load center. Transmission lines and substations are subject to failures of various kinds. A single line is vulnerable to any and all of these potential failures. When a failure occurs the power supply over that line is entirely lost. A double circuit even on the same set of towers is less vulnerable and more reliable than a single circuit, since many of the failures could affect only one circuit. There would still remain the chances

EXHIBIT 2.1

of a tower failure or other failures which would affect both circuits, so it would still not be entirely firm but could be considered as being within reasonable bounds of reliability. Two circuits on separate structures but within the same right of way would be considered more reliable than two separate circuits on the same structure, but less reliable than separate circuits on separated alignments.

The whole tenor of our discussion has to do with what might be termed the degree of reliability. Our letter of February 25, 1964 was couched in terms of 100 percent reliability. Such reliability may not be desirable from an economic point of view. Assured firm power (100 percent) might cost half again as much as power with a somewhat lesser degree of reliability. The purchaser of power might be better satisfied and more willing to purchase the less reliable power supply. Our concern is that the alternatives be fully considered and the degree of reliability recognized in whatever plan is developed, and that the prospective purchasers are aware of any lack of reliability that is involved.

Sincerely yours,

M. Boyd Austin

M. Boyd Austin
Regional Engineer

EXHIBIT 2.2

FEDERAL POWER COMMISSION
REGIONAL OFFICE
555 BATTERY STREET, ROOM 415
SAN FRANCISCO 11, CALIF.
94111

February 19, 1965

AIR MAIL

Colonel Clare F. Farley
District Engineer
U. S. Army Engineer District, Alaska
P. O. Box 7002
Anchorage, Alaska 99051

Dear Colonel Farley:

Reference is made to the February 17 telephone request from Messrs. Lambert and Wade for a value of power based on federal financing for use in the Corps' studies of the Snettisham Project.

The value of hydroelectric power at-market in Juneau, Alaska, based on cost of alternative power produced by a federally financed steam-electric plant, is estimated to be $29.29 per kilowatt-year for dependable capacity plus 6.91 mills per kilowatt-hour. This estimate excludes taxes and is based on cost of money at 3.125 percent. As in the estimated value furnished in 1960 for a privately financed plant, the steam-electric plant assumed for this value has 3 units with a total capacity of 49,500 kilowatts, and is located at Juneau. The cost of fuel is based on bunker oil at 50.4 cents per million Btu.

Please advise if we can be of further assistance.

Sincerely yours,

M. Boyd Austin

M. Boyd Austin
Regional Engineer

EXHIBIT 3.1

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ALASKA DISTRICT HEADQUARTERS
P. O. BOX 2567, JUNEAU, ALASKA 99801

IN REPLY REFER TO: 620

February 24, 1965

AIRMAIL

District Engineer
U.S. Army Engineer District, Alaska
P.O. Box 7002
Anchorage, Alaska 99501

Dear Sir:

Enclosed is a tabulation of hourly generation values for the Juneau area during the period from November 18, through 25, 1964 as obtained from the Alaska Electric Light and Power Company and Alaska-Juneau Industries, Inc. These values were taken during what was considered a normal fall week and should be representative of the load pattern during the season.

Also enclosed is an updated forecast of the Juneau area load requirements for use with the Snettisham Project studies. This forecast was prepared in conjunction with a representative of the Alaska Electric Light and Power Company, the local distributor in the area. The forecast has been revised to include the trend of the latest load developments, and the accelerated rate of growth, which has developed in the area since Statehood.

As viewed at the present time, we believe this to be a very realistic forecast for the area.

Sincerely yours,

Geo. N. Pierce
George N. Pierce
District Manager

Enclosures

EXHIBIT 4.1

POWER & ENERGY REQUIREMENTS - JUNEAU AREA - 1965 FORECAST

Calendar Year	Net Energy X 1000 KWH		Net Peak Kilowatts		Load Factor
1950	14,050		3,200		50.1
51	15,522		3,650	Load Growth	48.8
52	17,364	Load Growth Historical Average	4,090		48.5
53	19,771		4,350		51.9
54	21,108		5,025	6.0%	48.0
1955	22,913		5,030		52.0
56	23,810		5,353		50.8
57	23,193	8.0%	4,837		54.7
3/ 58	24,402		5,105		54.6
59	26,437		5,465		55.2
1960	29,156		5,837		57.0
61	32,282		7,750	10.9 %	47.6
62	34,712		7,056		56.0
63	37,150		9,044		46.9
1/ 64	41,327		9,424		50.0
1965	45,400		10,370		50.0
66	49,900		11,400		50.0
67	54,900		12,540	10%	50.0
68	60,400		13,800		50.0
69	66,500		15,180		50.0
2/ 1970	73,100		16,690		50.0
71	83,500		18,690		51.0
72	95,400		20,940	12%	52.0
73	108,900		23,450		53.0
74	124,200		26,260		54.0
1975	141,700		29,410		55.0
76	155,900		32,350		
77	171,500		35,590		
78	188,600		39,140		
79	207,500		43,060	10%	
1980	228,200		47,370		
81	251,000		52,100		
82	276,100		57,310		
83	303,700		63,040		
84	334,100		69,350		
85	367,500		76 300		
86	404,300		83 900		
87	444,700		92 300		
88	489,100		101 500		

1/ All preceding values are actual record.

2/ Project assumed to go into operation end of C.Y. 1970

3/ Bill passed for Statehood.

EXHIBIT 4.1
Enclosure

FEDERAL POWER COMMISSION
REGIONAL OFFICE
555 BATTERY STREET, ROOM 415
SAN FRANCISCO 11, CALIF.

February 25, 1964

AIR MAIL

Colonel K. T. Sawyer
District Engineer
U. S. Army Engineer District, Alaska
Corps of Engineers
P. O. Box 7002
Anchorage, Alaska 99501

Dear Colonel Sawyer:

This is in answer to your letter of January 31, 1964 (your file reference NPAEN-PR-TP) requesting comments on specific questions which concern your study of the Snettisham Project.

a. The amount of reserve capacity required to maintain firm service would be equal to the largest reduction in total system dependable capacity which might result from an outage of a generating unit or transmission circuit at the time of the system peak.

At the present time the power supply in the Juneau area consists of small hydroelectric and internal-combustion plant generating units. The largest unit is 3,500 kilowatts. Another unit or a group of units, in reserve, equal in capacity to this unit would permit loads to be served on a firm basis. No reserve capacity would be needed if some loads could be dropped until the largest unit is returned to service, in the event of a forced outage.

With the addition of generating capacity such as may be installed at the Snettisham Project, firm service to the loads would be maintained by providing standby capacity in other power plants in the Juneau area equal to the dependable capacity of the largest project unit, or the capacity of its largest transmission circuit. This assumes that the greatest reduction in the supply to the Juneau area would be due to the loss of a Snettisham unit or line. On the other hand, it is conceivable that a thermal plant might be built or other hydro installations may be constructed with units larger than installed at Snettisham.

b. No amount of project power would be firm at the Juneau market if delivery is to be by one transmission circuit.

c. The alternative source of power to the project is considered by us at present to be a privately financed steam-electric plant located at Juneau tidewater. If power can be made dependably available from outlying system sources at a lower market cost, this cost would be a measure of the value of project power at market.

The value of hydroelectric power at Juneau based on cost of steam-electric power estimated in 1960 was $65.11 per kilowatt-year for dependable capacity plus 6.91 mills per kilowatt-hour for energy. The total unit value of power for a 70 percent load factor delivery, amounts to 17.53 mills per kilowatt-hour. This value was based on financing of a 49,500-kilowatt steam-electric plant with cost of money at 7 percent and with taxes of 6.77 percent of the investment. The cost for fuel was based on bunker oil at Juneau delivered for $3.20 per barrel.

By our letter of February 14, 1964, you were furnished at-steam plant values for the southwest area of Alaska for various plant sizes. These were based on cost of producing power at a 3 percent rate of interest and with no taxes. If the alternative plant capacity is to be initially comparable in size to the Snettisham installation, the value (because of the high cost of smaller units and other factors than were used for developing estimates of values furnished) would be somewhat greater.

Sincerely yours,

M. Boyd Austin

M. Boyd Austin
Regional Engineer

EXHIBIT 5.2

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ALASKA DISTRICT HEADQUARTERS
P. O. BOX 2567. JUNEAU. ALASKA 99801

IN REPLY
REFER TO: 100

March 29, 1965

AIRMAIL

District Engineer
U.S. Army Engineer District, Alaska
P. O. Box 7002
Anchorage, Alaska 99501

Dear Sir:

This is to confirm our March 24, 1965 discussions with members of your staff, and with Messrs. Mark L. Nelson and W. L. Sasser of the North Pacific Division Office, relative to certain functional design criteria for the Snettisham Project.

With respect to total number of units, the discussions centered around a total of five units (three for Long Lake and two for Crater Lake) versus three units (two for Long and one for Crater). Due primarily to the difficulties which would be encountered in design, fabrication, installation, and operation and maintenance of the penstock interconnections requested in my letter to you dated February 11, 1965, together with the additional costs involved, a five-unit installation appears highly undesirable. We would much prefer a three-unit installation. Additionally, the larger units are more desirable from a system operating standpoint.

To provide greater operating flexibility, and to minimize stocks of spare parts required to be kept on hand, we would prefer that all three generators have the same kva rating. It is understood that this would result in a lower overall plant factor for the Crater Lake unit than for the Long Lake units, but this would not present any operating problem.

Also discussed was the matter of dependable plant capacity, and whether or not sufficient reserves will be available from other sources to at least equal the capacity of the largest unit at Snettisham. In this

EXHIBIT 6.1

connection, the local power supplying entities estimate there will be approximately 20,000 kw of capacity available for standby in the Juneau area by the end of 1969.

On the subject of arrangement of tunnel intake stoplogs and trashracks, my letter to you of February 11, 1965 visualized separate slots for these two features. At the March 24 meeting, your staff suggested the possibility of a single slot for stoplogs only, with trashracks fixed in place by means of stainless steel bolts. This latter arrangement would be satisfactory to us.

Sincerely yours,

Geo. N. Pierce

George N. Pierce
District Manager

EXHIBIT 6.2

UNITED STATES
DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

ALASKA DISTRICT HEADQUARTERS
P. O. BOX 2567, JUNEAU, ALASKA

IN REPLY REFER TO: 620

April 1, 1965

AIRMAIL

District Engineer
U.S. Army Engineer District, Alaska
Post Office Box 7002
Anchorage, Alaska 99501

Dear Sir:

In accordance with the request of your staff during our March 24, 1965 meeting, we are furnishing our recommendations for power factor rating of Snettisham Project electrical equipment.

It is reported by the local power company that the area load power factor varies between 0.90 and 0.95; therefore, we recommend that the Project be designed for 0.90 power factor operation.

We would prefer that the generators be rated at a nameplate power factor of not greater than 0.90 in order to give a fairly wide range of voltage control without undue sacrifice of nameplate kilowatt capacity. It is realized that, as the peak load approaches the nameplate capacity of the Project, the need for supplemental voltage control equipment in the form of voltage regulator and/or banks of capacitors situated at the Juneau Substation will probably be required. This can readily be worked out during the later stages of construction if proper provisions are made in the initial stage.

The switchyard and substation capacities should be sized to the capacity of the generating units. If multiple transformers are used, an additional emergency rating (by use of supplemental cooling) should be provided against the possibility of a failure of one of the parallel transformers. The capacity of the Juneau Substation could be less than that of the Switchyard by amount of line losses.

Sincerely yours,

Geo. N. Pierce

George N. Pierce
District Manager

EXHIBIT 7.1

UNITED STATES
DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

ALASKA DISTRICT HEADQUARTERS
P. O. BOX 2567, JUNEAU, ALASKA

IN REPLY REFER TO: 100

April 1, 1965

AIRMAIL

District Engineer
U.S. Army Engineer District, Alaska
P. O. Box 7002
Anchorage, Alaska 99501

Dear Sir:

This is further to my letter to you of March 29, 1965 relative to our discussions of March 24, 1965, with representatives of your office and of the North Pacific Division Office, on functional design criteria for the Snettisham Project.

It was brought out that Corps of Engineers specifications now require that generators shall be capable of operating continuously at 15 percent overload. It is also the practice of the Corps to utilize this 15 percent overload capability in measuring project benefits for benefit-cost analyses. This is reflected in Table 5 of the draft of Snettisham Design Memorandum No. 3, which we presently have under informal review in this office.

At the March 24 meeting, we agreed to advise you of Bureau of Reclamation practices with respect to the amount of generator overload capacity required by our standard specifications, the use or non-use of such overload capacity in benefit-cost analyses, and whether or not such overload capacity is considered saleable under Department of the Interior power marketing policies.

The Bureau's treatment of generator overload capacity has been discussed both with the Office of our Commissioner and of our Chief Engineer. Current Bureau practices are as follows:

1. In a number of recent instances, our generator specifications have required a continuous overload capability of 15 percent at rated voltage, power factor and frequency.

2. Generator overload capability is not considered in measuring project benefits, either in benefit-cost analyses for plan formulation, or in determination of project feasibility.

3. Generator overload capability is not considered in our average rate and repayment analyses, which determine the rates at which power must be sold to recover, with interest, all project costs allocated to power.

4. Power from a project is marketed only up to total name place capacity, regardless of generator overload capability, even in those instances where a continuous overload capability has been included in the specifications.

Thus, while it is desirable that your specifications for Snettisham generators include a requirement for a continuous overload capability of 15 percent, when the Project goes into operation we will limit the contract obligation of the Project to meet area demands to total name plate capacity.

In connection with scoping the Snettisham Project, and in particular the determination of the desirability of a dam at Long Lake, the effect of any resulting increase in required power rates must be seriously considered. We already know that Snettisham power rates will be higher than those indicated in the documents on which authorization was based, due to increases both in interest rate and in construction costs. This amount of rate increase alone will affect the marketability of Project power, particularly in the industrial field. It would certainly be advantageous to the Project and to the Juneau area if a dam at Long Lake would make additional power and energy available at no increase in unit power cost. However, any significant increase in power rates which would be required by the addition of a dam at Long Lake could only have an additional adverse effect on the marketability of Project power, and on the ability of the Project to return to the Treasury all Project costs, with interest.

Sincerely yours,

Geo. N. Pierce

George N. Pierce
District Manager

EXHIBIT 8.2

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ALASKA DISTRICT HEADQUARTERS
P. O. BOX 2567, JUNEAU, ALASKA

IN REPLY
REFER TO: 700

April 23, 1965

AIRMAIL

District Engineer
U.S. Army Engineer District, Alaska
Corps of Engineers
P. O. Box 7002
Anchorage, Alaska 99501

Dear Sir:

We have used the revised Snettisham cost estimates and construction schedules transmitted by your letter of 6 April 1965, reference NPAEN-PR-R, in computation of firm power rate and in benefit-cost comparisons for each of the seven alternates. A summary tabulation of the results of these computations for the overall project is attached.

Our computations used the annual O&M estimate of $390,000 contained in our letter of April 6, 1965 and a separately determined replacement estimate. The O&M estimate was held constant for all plans and stages, since a full complement of men and maintenance equipment will be required from the start of operation, while the replacement estimate has varied to reflect stage development. Benefit determinations used the firm power values of $29.29 per kilowatt-year, and 6.91 mills per kilowatt-hour which were obtained from your office. At our annual load factor of 55%, these rates are equivalent to a single charge of 13 mills per kilowatt-hour for firm energy. Non-firm energy benefits and revenues were assumed to be 7 and 5 mills per kilowatt-hour, respectively.

We note your comment that the current cost estimates do not reflect changes in costs for penstock interconnections, transmission line access roads, and revision of housing requirements. However, these changes should be equivalent for the various alternates and should have little effect on selection of dam size.

On the basis of the above evaluations, we concur in your finding that inclusion in the plan of development of a dam at Long Lake is merited. We also find that the alternate which would raise the Long Lake water surface elevation to 895 feet would produce the greatest excess of benefits over costs.

Our average rate and repayment analyses show that the most favorable firm power rate (9 mills/kwh) would be obtained with the plan which would raise Long Lake to elevation 840. The other alternates, including the no-dam plan and the 895 alternate, would require slightly higher power rates. It appears that the increase in the firm power rates for the more favorable alternate dam heights would not be so great as to affect the willingness of potential power customers to utilize all available project power. This condition likely would not prevail, however, should there be any further significant increases in estimated costs.

There was one additional point discussed during our March 24, 1965 discussions with representatives of your office and of the North Pacific Division, which could effect your decision whether or not to include a dam at Long Lake in your recommended plan of development. It was the consensus of that meeting that, in view of the urgent need for Snettisham power at the earliest possible date, if inclusion of a Long Lake dam would require reauthorization of the Project by the Congress, no dam should be recommended.

Sincerely yours,

Geo. N. Pierce

George N. Pierce
District Manager

Enclosure

CHARTS

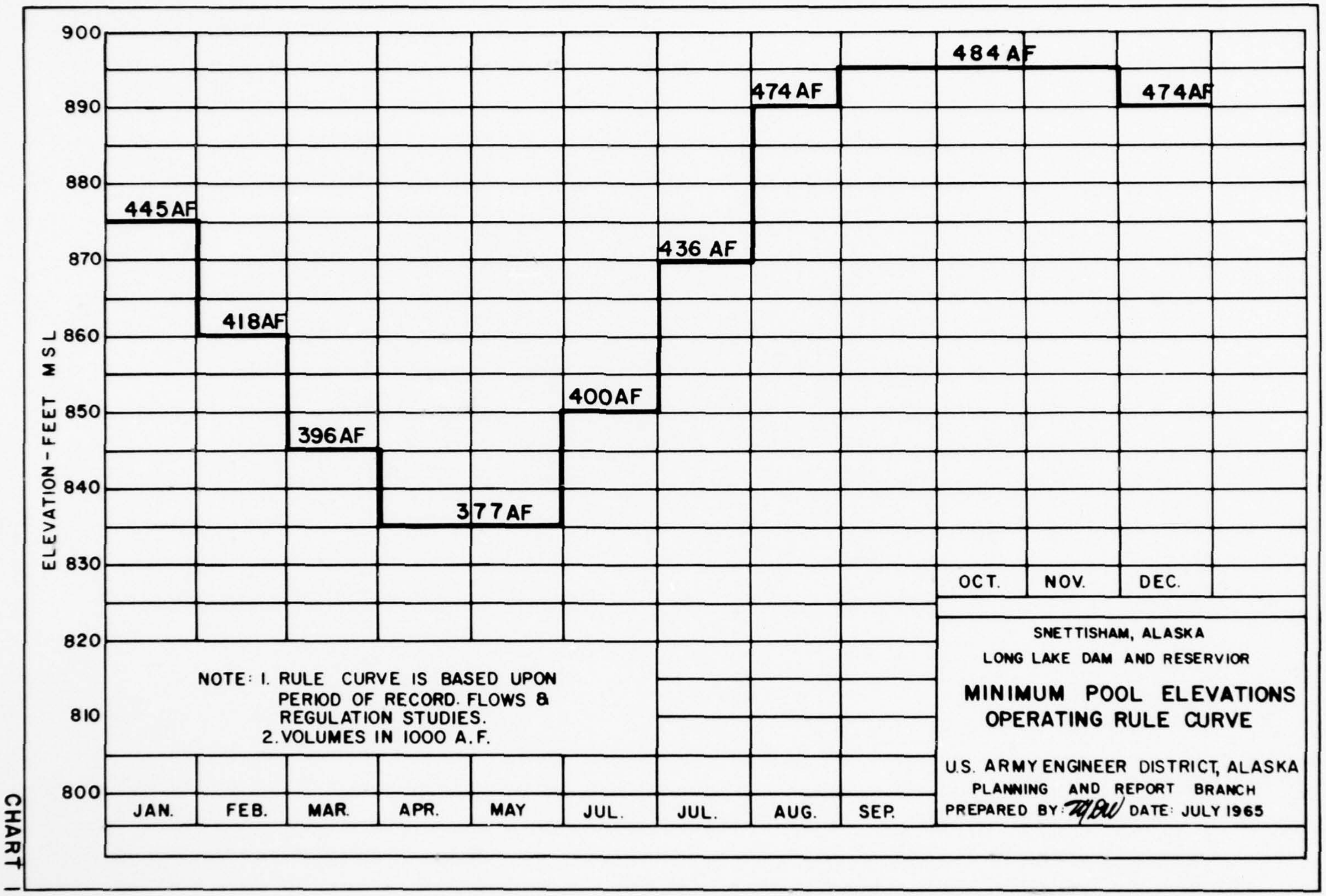

ELEVATION - FEET MSL
900
890
880
870
860
850
840
830
820
810
800
445 AF
418 AF
396 AF
377 AF
400 AF
436 AF
474 AF
484 AF
474 AF
JAN.
FEB.
MAR.
APR.
MAY
JUL.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.
NOTE: 1. RULE CURVE IS BASED UPON PERIOD OF RECORD. FLOWS & REGULATION STUDIES.
2. VOLUMES IN 1000 A.F.
SNETTISHAM, ALASKA
LONG LAKE DAM AND RESERVIOR
MINIMUM POOL ELEVATIONS
OPERATING RULE CURVE
U.S. ARMY ENGINEER DISTRICT, ALASKA
PLANNING AND REPORT BRANCH
PREPARED BY: DATE: JULY 1965

CHART 1

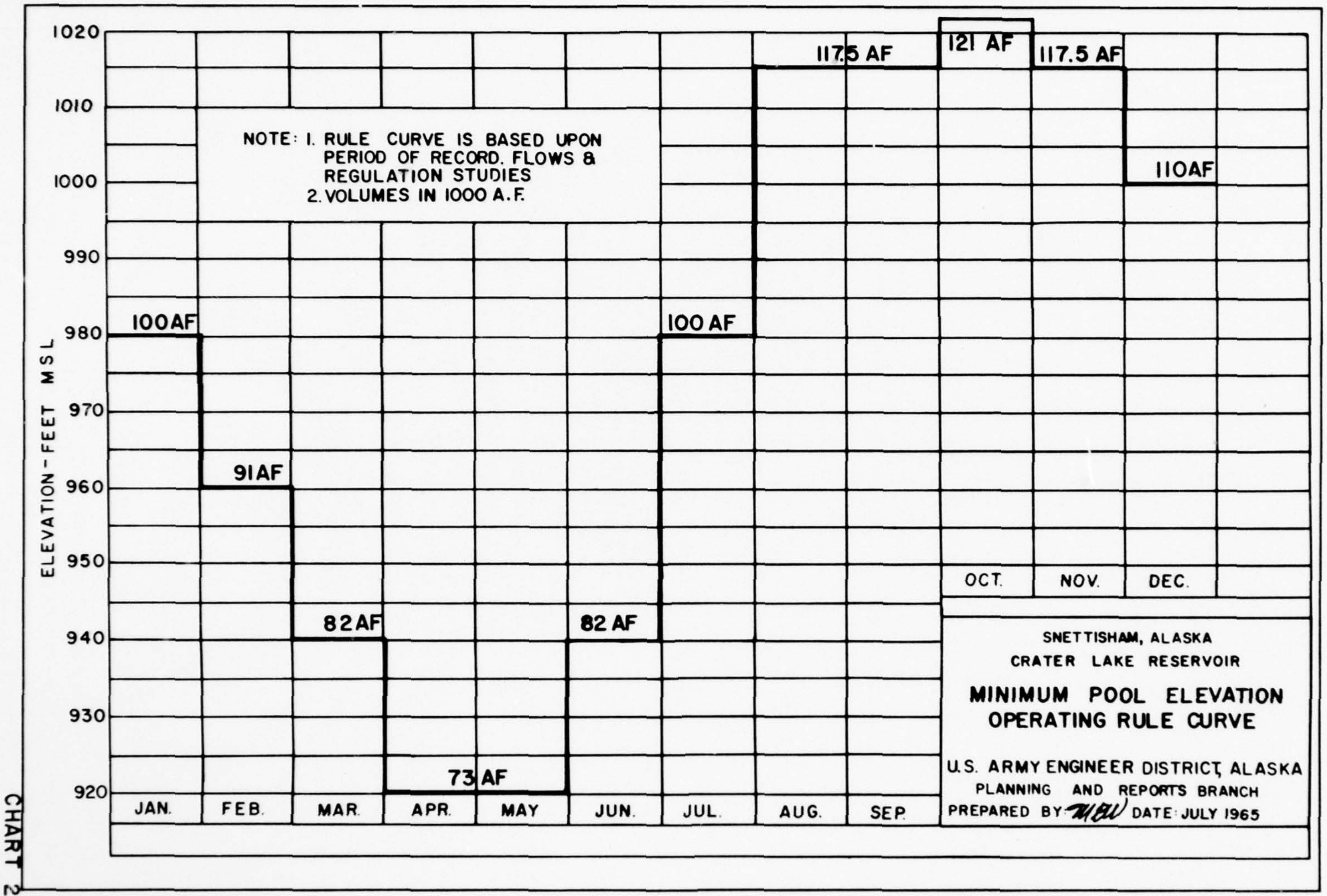
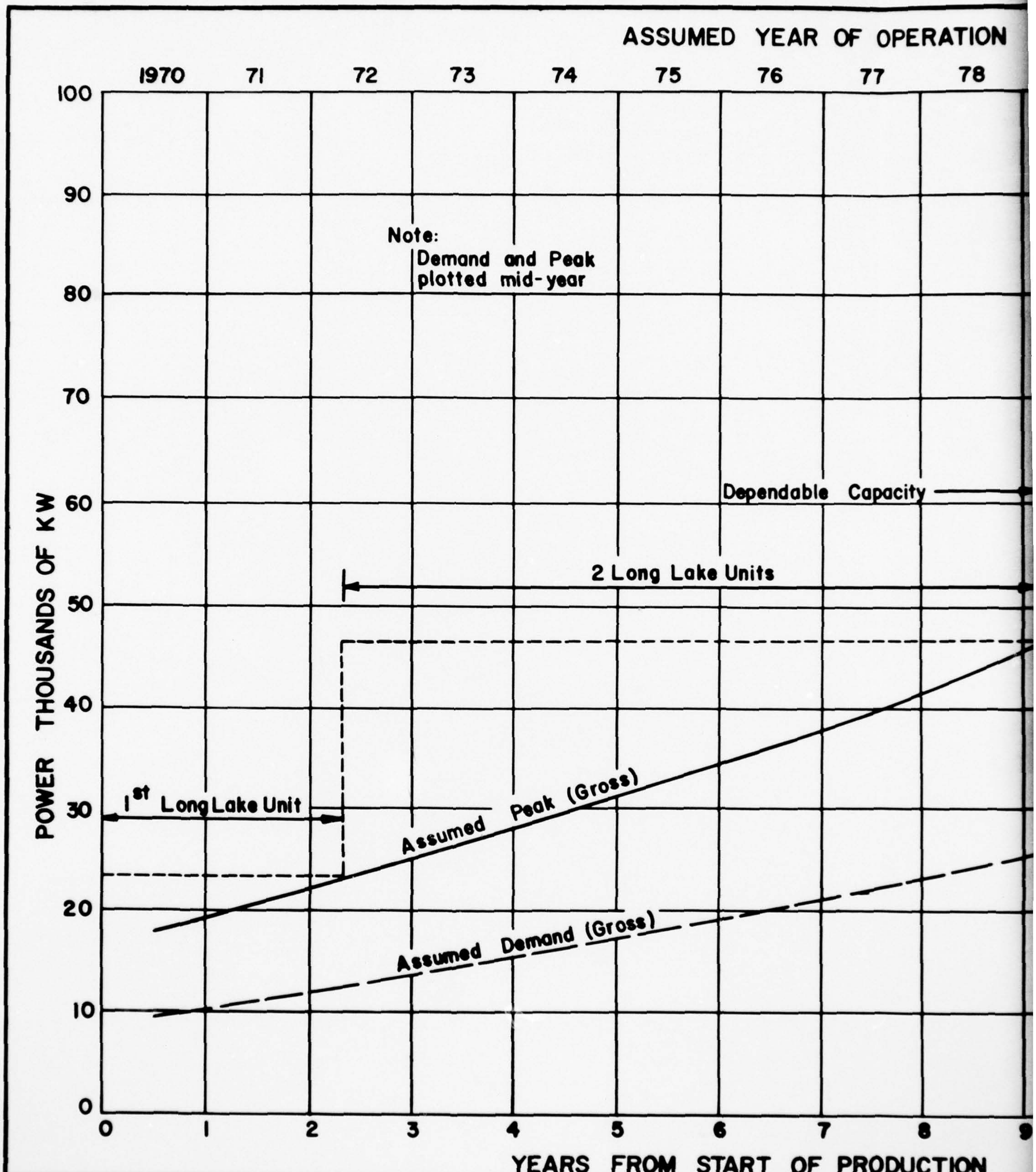


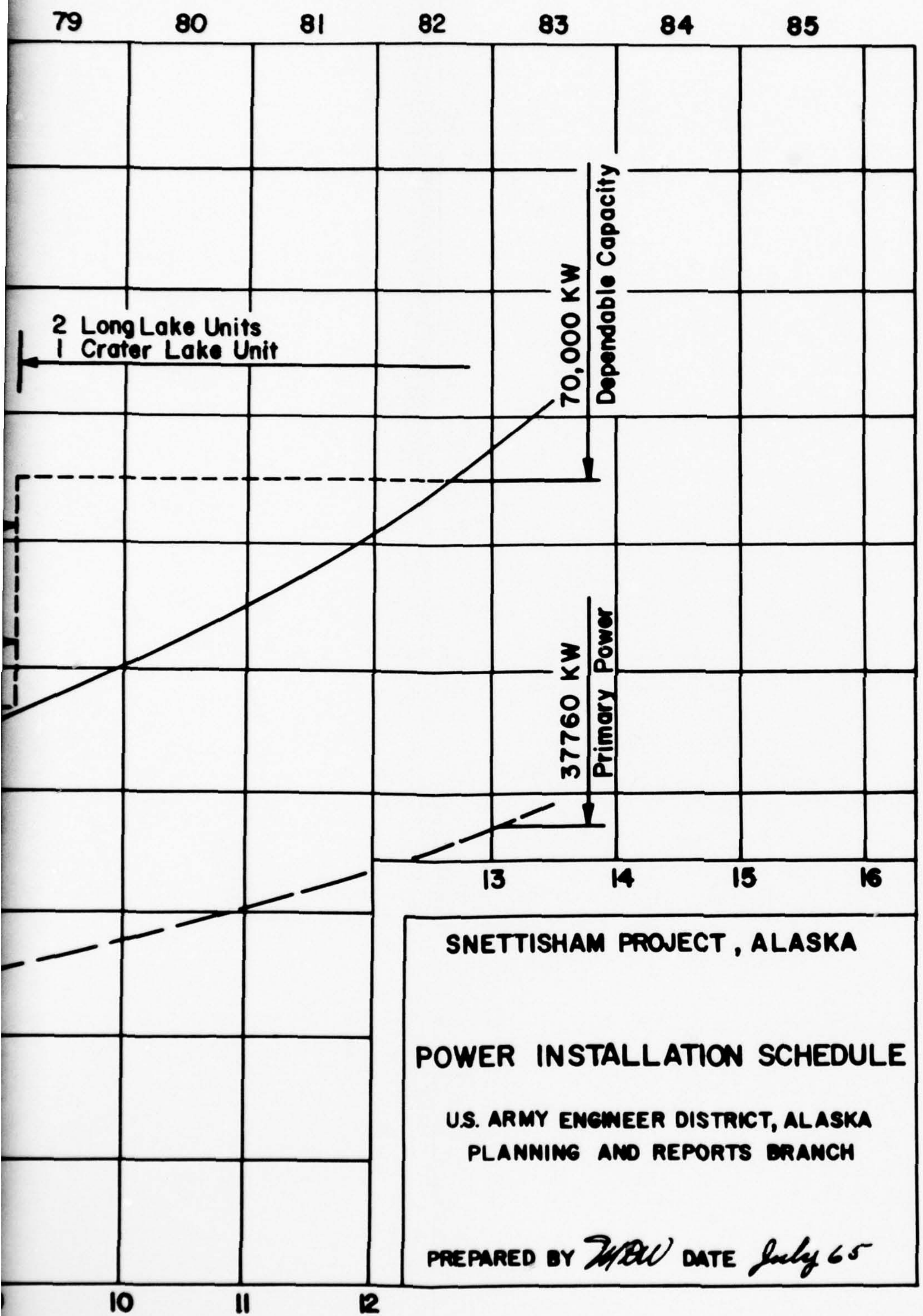
CHART 2

DESIGN MEMORANDUM 7 APPENDIX A CHART 2



ASSUMED YEAR OF OPERATION
1970
71
72
73
74
75
76
77
78
100
90
80
70
60
50
40
30
20
10
0
POWER THOUSANDS OF KW
Note:
Demand and Peak
plotted mid-year
Dependable Capacity
2 Long Lake Units
1st Long Lake Unit
Assumed Peak (Gross)
Assumed Demand (Gross)
0
1
2
3
4
5
6
7
8
9
YEARS FROM START OF PRODUCTION

1267-66



SNETTISHAM PROJECT, ALASKA

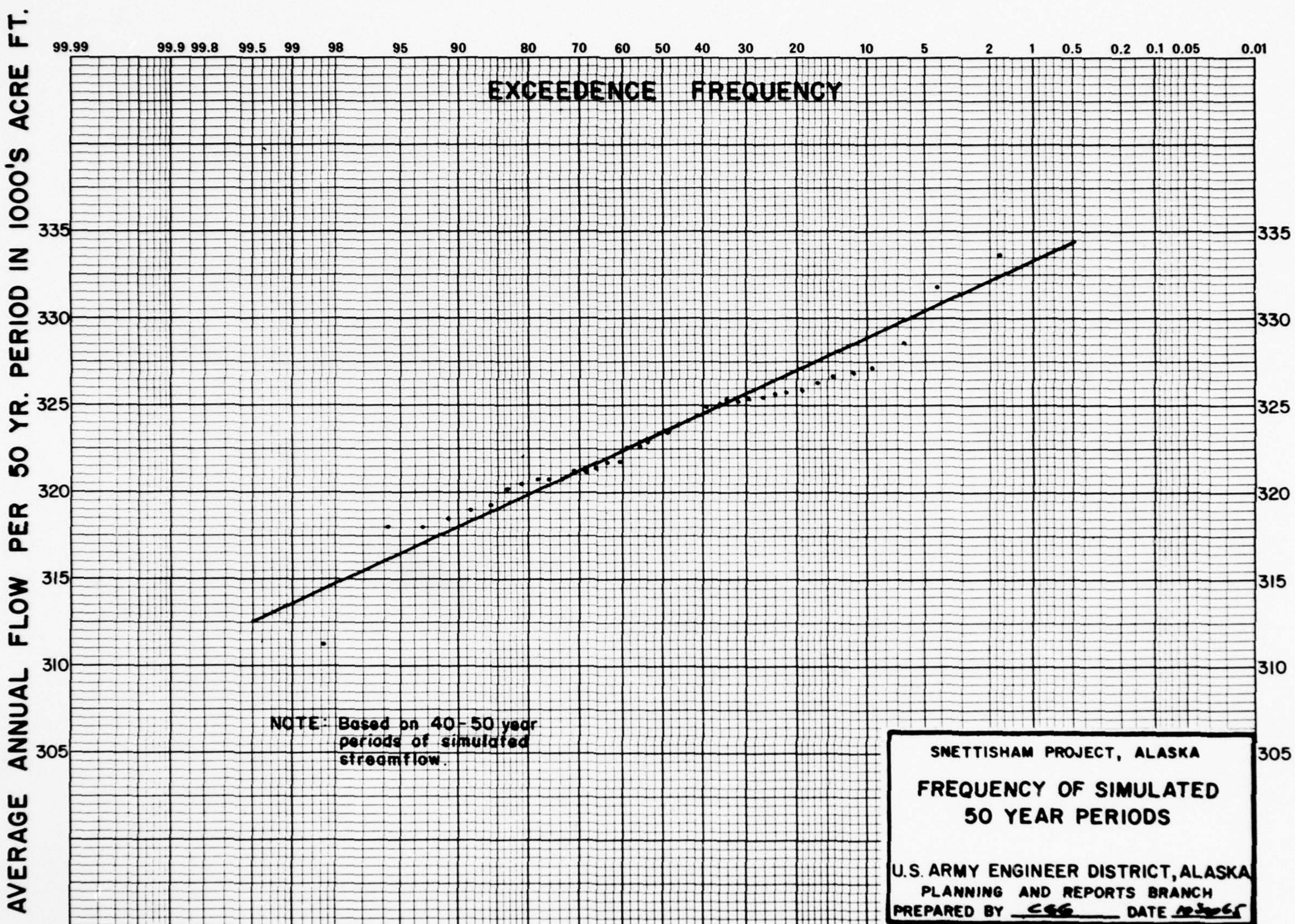
POWER INSTALLATION SCHEDULE

U.S. ARMY ENGINEER DISTRICT, ALASKA
PLANNING AND REPORTS BRANCH

PREPARED BY WBW DATE July 65

DESIGN MEMORANDUM 7 APPENDIX A CHART 3

2



DESIGN MEMORANDUM 7 APPENDIX A CHART 4

TABLES

TABLE 1

HISTORICAL DATA - JUNEAU AREA POWER AND ENERGY DEMAND

1950 through 1955

PERIOD	1950 PEAK KW	1950 1,000 KWH	1950 DAYS	1951 PEAK KW	1951 1,000 KWH	1951 DAYS	1952 PEAK KW	1952 1,000 KWH	1952 DAYS	1953 PEAK KW	1953 1,000 KWH	1953 DAYS	1954 PEAK KW	1954 1,000 KWH	1954 DAYS	1955 PEAK KW	1955 1,000 KWH	1955 DAYS
JAN	2950	1,290		3245	1,391		3660	1,634		4100	1,774		4325	1,848		4100	1,909	
FEB	2740	1,096		3070	1,227		3320	1,373		3600	1,498		3960	1,662		4350	1,796	
MAR	2390	1,136		2870	1,287		2870	1,397		3390	1,599		4540	1,763		4290	2,029	
APR	2420	1,084		2775	1,190		3040	1,350		3500	1,410		3350	1,683		4320	1,847	
MAY	3200	1,132		2645	1,246		2890	1,371		3020	1,454		3380	1,608		4200	1,798	
JUN	2360	1,064		2380	1,207		2640	1,332		3110	1,460		3260	1,627		4000	1,705	
JUL	2280	1,126		2590	1,224		2640	1,376		3630	1,614		3140	1,679		3620	1,728	
AUG	2580	1,131		2845	1,232		2820	1,415		3680	1,652		3500	1,633		3720	1,854	
SEP	2640	1,155		3160	1,243		3200	1,431		3960	1,776		3600	1,752		3920	1,797	
OCT	2780	1,239		3395	1,363		3620	1,520		4130	1,829		4060	1,889		4000	1,978	
NOV	3200	1,269		3630	1,429		4090	1,518		4350	1,813		4210	1,912		5030	2,107	
DEC	3100	1,328		3630	1,482		3730	1,647		4150	1,892		5025	2,047		4700	2,365	
ANNUAL	3200	14,050		3630	15,521		4090	17,364		4350	19,771		5025	21,108		5030	22,913	
L.FACTOR		50.1%			48.8%			48.5%			51.9%			48.0%			52.0%	
%GROWTH				13.4	10.5		12.7	11.9		6.4	13.9		15.5	6.8		0.1	8.6	

NOTES:

1. The above information from records of Alaska Electric Light and Power Company, Juneau, Alaska
2. This only includes power sold by Alaska Light and Power Company

TABLE 1 (cont'd)

HISTORICAL DATA - JUNEAU AREA POWER AND ENERGY DEMAND

1956 through 1961

	19 56			19 57			19 58			19 59			19 60			19 61		
PERIOD	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS
JAN	5310	2,367		4837	2,135		4741	2,203		5312	2,484		5341	2,530		6080	2,897	
FEB	4096	2,118		4256	1,888		4550	2,004		4373	2,160		5410	2,402		5450	2,655	
MAR	3705	2,071		3937	1,922		4005	2,001		4172	2,272		4688	2,499		4964	2,781	
APR	3668	1,771		3968	1,828		4160	1,894		4430	2,136		4543	2,333		5250	2,603	
MAY	3835	1,796		3780	1,899		4284	1,953		3399	2,098		4558	2,249		5486	2,504	
JUN	3392	1,792		3750	1,747		3906	1,760		4047	2,005		4558	2,190		5016	2,405	
JUL	3790	1,850		4191	1,773		3900	1,852		4419	2,096		4357	2,220		5230	2,386	
AUG	3709	1,990		3637	1,826		3938	1,950		4393	2,133		4639	2,322		5159	2,544	
SEP	4096	1,915		4000	1,901		4318	2,054		4773	2,182		4655	2,461		6062	2,647	
OCT	4388	1,990		4788	2,029		4672	2,190		4908	2,348		5055	2,630		5610	2,885	
NOV	5353	1,990		4580	2,050		4828	2,155		5465	2,381		5593	2,759		6903	3,028	
DEC	4704	2,160		4747	2,195		5105	2,386		5407	2,564		5837	2,884		7750	3,277	
ANNUAL	5353	23,810		4837	23,193		5105	24,402		5465	26,859		5837	29,479		7750	32,612	
L.FACTOR		50.8%			54.7%			54.6%			56.1%			57.7%			43.0%	
%GROWTH	6.4	3.9		-9.6	-2.6		5.5	5.2		7.1	10.1		6.8	9.8		32.8	10.6	

TABLE 1 (cont'd)

HISTORICAL DATA - JUNEAU AREA POWER AND ENERGY DEMAND

1962 to present

	19 62			19 63			19 64			19 65			19__			19__		
PERIOD	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS	PEAK KW	1,000 KWH	DAYS
JAN	7056	3,305		6295	3,057		9158	3,741		10023	4137							
FEB	5583	2,923		5899	2,824		7695	3,491		9092	3643							
MAR	6177	3,040		7334	2,700		7401	3,587		7952	3723							
APR	5845	2,786		6270	3,010		7182	3,374										
MAY	5617	2,744		5985	3,028		6992	3,205										
JUN	5464	2,585		5947	2,801		6555	3,109										
JUL	5480	2,596		6137	2,939		6621	3,129										
AUG	5630	2,686		6175	2,971		6650	3,110										
SEP	5731	2,794		6603	3,164		7021	3,336										
OCT	6110	3,045		7800	3,183		8027	3,630										
NOV	6747	3,080		9044	3,860		9367	3,681										
DEC	6510	3,123		8408	3,613		9424	4,144										
ANNUAL	7056	34,712		9044	37,150		9424	41,537										
L.FACTOR		567.			46.97			50.3%										
%GROWTH	-9.0	6.4		25.7	7.0		4.2	11.8										

TABLE 1 (cont'd)

TABLE 2

Present Power Supply -- Juneau Power Market Area

Plant	Owner-Ship	Installed Capacity	Capability when Operating KW	Present firm Capacity KW	Approximate date Installed	Number Units	Unit Capacity KW	Unit Type
Salmon Creek #1	A-J	2,800	1,600	1,600	1915	2	1,400	Hydro
							1,400	Hydro
Salmon Creek #2	A-J	2,800	2,800	2,800	1915	2	1,400	Hydro
							1,400	Hydro
Annex Creek	A-J	2,800	3,600	2,800	1915	2	1,400	Hydro
							1,400	Hydro
Sheep Creek	A-J	2,225	2,150	Inoperative	1914	3	1,000	Hydro
							1,000	Hydro
							225	Hydro
Nugget Creek	A-J	2,880	2,350	Inoperative	1914	2	1,000	Hydro
							1,880	Hydro
Treadwell Ditch #1	A-J	800	800	(Inoperative) (No storage)	1922	1	810	Hydro
Juneau Steam Plant	A-J	8,000	8,000	Inoperative	1917	2	6,000	Steam
							2,000	Steam
Gold Creek Hydro	AEL&P	1,600	1,600	No storage	1914	3	400	Hydro
					1914		400	Hydro
					1950		800	Hydro
Gold Creek Diesel	AEL&P	7,140	7,760	7,390	1952	4	1,250	Diesel
					1954		1,250	Diesel
					1961		1,140	Diesel
					1963		4,120	Diesel
TOTAL		31,045	30,660	14,590				
Juneau Lumber Co. 1/		1,000	unknown	unknown				

1/ Not available for public use.

TABLE 3

JUNEAU AREA
ENERGY & PEAK REQUIREMENTS
1965 Forecast 1/

Fiscal Year		Net Energy 1000 KWH	Gross Energy 1000 KWH	Net Peak KW	Gross Peak KW	Load Factor %
1950		14800	15750	3400	3650	50.1
1951		16450	17500	3850	4100	48.8
1952		18550	19750	4200	4500	48.5
1953		20450	21750	4700	5000	51.9
1954		22000	23400	5050	5350	48.0
1955		23350	24850	5200	5500	52.0
1956		23500	25000	5100	5400	50.8
1957		23800	25300	4950	5300	54.7
1958	4/	25400	27000	5300	5600	54.6
1959		27800	29550	5650	6000	55.2
1960		30700	32650	6800	7250	57.0
1961		33500	35650	7400	7850	47.6
1962		35950	38250	8050	8550	56.0
1963		39250	41750	9250	9800	46.9
1964	2/	43350	46100	9900	10550	50.0
1965		47650	50700	10900	11600	50.0
1966		52400	55750	11950	12800	50.0
1967		57650	61350	13150	14000	50.0
1968		63450	67500	14500	15400	50.0
1969		69800	74250	15950	16950	50.0
1970	3/	78300	83300	17700	18800	50.0
1971		89450	95150	19800	21100	51.0
1972		102150	108650	22200	23600	52.0
1973		116550	124000	24850	26450	53.0
1974		132950	141450	27850	29600	54.0
1975		148800	158300	30900	32850	55.0
1976		163700	174150	33950	36150	55.0
1977		180050	191550	37350	39750	55.0
1978		198050	210700	41100	43700	55.0
1979		217850	231750	45200	48100	55.0
1980		239600	254900	49800	52900	55.0
1981		263550	280350	54700	58200	55.0
1982		289900	308400	60200	64000	55.0
1983		318900	339250	66200	70400	55.0
1984		350800	373200	72800	77500	55.0
1985		385900	410500	80100	85200	55.0
1986		424500	451600	88100	93700	55.0
1987		466900	496700	96900	103100	55.0
1988		513600	546400	106600	113400	55.0
1989		565000	601000	117300	124800	55.0
1990		621400	661000	129000	137250	55.0

1/ Based on U.S.B.R. letter of 24 February 1965, exhibit 4.
2/ All preceding values are actual record of net requirements.
3/ Project assumed to go into operation end of C.Y. 1969.
4/ Bill passed for Statehood.

TABLE 4

PRESENT JUNEAU ENERGY DEMAND

Load Distribudtion (Percents of Total KW-hr)

Annual Month	KWH	%	Weekly (November) Day	KWH	%	Daily - Fall (Nov) 2 Hr Aver	KWH
January	3,001,000	8.91	Thursday	148,190	14.22	12 Mid	5650
February	2,736,000	8.12	Friday	148,350	14.24	2	3650
March	2,813,000	8.35	Saturday	138,800	13.32	4	3550
April	2,702,000	8.02	Sunday	130,450	12.53	6	3450
May	2,635,000	7.82	Monday	155,100	14.89	8	5050
June	2,513,000	7.46	Tuesday	158,900	15.25	10	7000
July	2,560,000	7.60	Wednesday	162,000	15.55	12 Noon	7450
August	2,628,000	7.80				2	7450
September	2,763,000	8.20				4	7500
October	2,951,000	8.76				6	8500
November	3,150,000	9.35				8	7900
December	3,238,000	9.61				10	6850
Load Factor		51.7			71.0		

NOTE: Loadshape for annual, weekly and daily fall and spring energy demand based upon the period 2 hour averages 19-24 Nov 64, 2-8 May 65, respectively.

%	2 Hr Aver	Daily - Spring (May) KWH	%
7.64	12 Mid	8525	6.22
4.93	2	7075	5.15
4.80	4	6610	4.82
4.66	6	7890	5.75
6.82	8	12180	8.87
9.46	10	14315	10.43
10.06	12 Noon	14165	10.32
10.06	2	14305	10.42
10.14	4	14480	10.55
11.49	6	13315	9.70
10.68	8	12845	9.36
9.26	10	11550	8.41
73.0			80.0

ods of record for 1959 to 1964, 19-25 Nov 64 and

TABLE 4

2

AD-A067 895 CORPS OF ENGINEERS ANCHORAGE AK ALASKA DISTRICT F/G 13/2
SNETTISHAM PROJECT ALASKA. FIRST STAGE DEVELOPMENT. DESIGN MEMO--ETC(U)
OCT 65

UNCLASSIFIED NL

2 OF 6

AD
A067895

TABLE 5

TYPICAL SUMMARY OF GROWTH PERIOD
LONG LAKE TO ELEVATION 895

YEAR	INFLOW	END OF YEAR Reservoir Content	POOL ELEVATION Feet Above MSL			Firm
	1000's of Acre-Feet		Maximum	Minimum	Average	Millions
1970	310	482	895	847	873	77.8
1971	260	481	895	889	894	86.7
1972	233	482	895	880	891	96.9
1973	217	466	895	879	890	107.8
1974	239	476	895	864	884	120.1
1975	288	475	895	869	887	138.9
1976	302	479	895	863	884	149.7
1977	271	474	895	861	884	166.4
1978	281	481	895	858	883	185.4
1979	221	461	895	852	879	206.7

NOTES: 1. Both units are assumed to be operating.

2. Uniform growth rate was assumed.

3. Inflows are high synthetic as developed.

ENERGY		WASTE
Available Secondary of Kilowatt	Total Hours	Non-Usable Acre-Feet
105.0	182.8	79,940
151.4	238.1	26,466
122.5	219.4	14,847
104.6	212.4	21,450
96.7	216.8	11,359
110.1	249.0	47,356
96.7	246.4	63,382
73.8	240.2	47,324
78.0	263.4	7,839
27.6	234.3	0

TABLE 5

TABLE 6

TYPICAL SUMMARY OF RESERVOIR OPERATION
LONG LAKE TO ELEVATION 895

YEAR	INFLOW	END OF YEAR Reservoir Content	POOL ELEVATION			ENERG	
			Feet Above MSL			Firm	Second
	1000's of Acre-Feet		Maximum	Minimum	Average	Millions of Ki	
1983	299	441.7	895	833	868	224.9	21.0
1984	344	461.5	895	819	860	225.6	18.0
1985	326	458.6	895	829	867	224.9	19.6
1986	291	446.8	895	835	866	224.9	3.6
1987	268	412.3	879	821	855	224.9	
1988	291	391.3	862	797	832	225.6	
1989	302	375.8	850	776	817	224.9	
1990	340	398.1	858	771	815	224.9	
1991	358	447.6	887	788	840	224.9	
1992	293	433.1	895	828	863	225.6	5.5
1993	346	467.7	895	830	865	224.9	9.3
1994	332	464.4	895	843	873	224.9	16.3
1995	316	475.3	895	832	867	224.9	5.9
1996	335	443.7	895	855	880	225.6	43.8
1997	284	424.8	888	820	854	224.9	
1998	282	399.8	864	814	842	224.9	
1999	312	397.5	866	776	825	224.9	
2000	292	371.9	852	773	818	225.6	
2001	423	478.7	895	761	820	224.9	
2002	352	453.4	895	845	875	224.9	30.2
2003	336	452.9	895	838	869	224.9	29.9
2004	357	466.9	895	829	866	225.6	30.2
2005	344	447.5	895	843	873	224.9	41.6
2006	298	445.1	885	830	860	224.9	
2007	357	444.8	895	830	866	224.9	36.2
2008	421	476.4	895	832	867	225.6	30.2
2009	357	468.8	895	851	879	224.9	40.9
2010	349	441.3	895	840	872	224.9	30.2
2011	315	455.6	895	819	861	224.9	0.5
2012	329	456.8	895	838	870	225.6	18.9
2013	349	456.9	895	832	870	224.9	26.7
2014	338	463.7	895	834	868	224.9	19.1
2015	252	415.4	888	830	861	224.9	
2016	266	365.5	861	798	833	225.6	
2017	358	400.6	864	752	805	224.9	
2018	332	422.7	884	786	835	224.9	
2019	296	410.8	861	818	841	224.9	
2020	278	376.5	864	787	830	225.6	

GY		WASTE
dary ilowatt	Total Hours	Non-Usable Acre-Feet
.0	245.9	
.0	243.6	
.6	244.5	5,299
.6	228.5	
	224.9	
	225.6	
	224.9	
	224.9	
	224.9	
.5	231.1	
.3	234.2	
.3	241.2	18,011
.9	230.8	
.8	269.4	15,920
	224.9	
	224.9	
	224.9	
	225.6	
	224.9	
.2	255.1	42,418
.9	254.8	654
.2	255.8	5,344
.6	266.5	13,026
	224.9	
.2	261.1	11,889
.2	255.8	51,517
.9	265.8	17,888
.2	255.1	40,791
.5	225.4	
.9	244.5	5,374
.7	251.6	17,447
.1	244.0	8,624
	224.9	
	225.6	
	224.9	
	224.9	
	224.9	
	225.6	

TABLE 6

TABLE 6
(cont'd)
TYPICAL SUMMARY OF RESERVOIR OPERATION
LONG LAKE TO ELEVATION 895

YEAR	INFLOW	END OF YEAR Reservoir Content	POOL ELEVATION Feet Above MSL Maximum	Minimum	Average	Firm Millions
	1000's of Acre-Feet					
2021	313	366.6	841	759	804	224.9
2022	308	349.2	835	756	799	224.9
2023	327	350.8	842	748	799	224.9
2024	309	327.3	825	738	788	225.6
2025	343	331.5	822	720	770	224.9
2026	394	400.3	874	735	801	224.9
2027	325	413.6	867	788	831	224.9
2028	311	417.9	883	809	845	225.6
2029	299	408.6	879	793	838	224.9
2030	344	444.5	887	791	839	224.9
2031	326	458.6	895	816	859	224.9
2032	291	446.8	895	835	866	225.6
Average					845	
Minimum				720		
Average Annual						225.1

NOTE: Starting year 1983 for Long Lake is used to be compatable with the water year 1980 fo

ENERGY		WASTE
Secondary	Total	Non-Usable
of Kilowatt	Hours	Acre-Feet
	224.9	
	224.9	
	224.9	
	225.6	
	224.9	
	224.9	
	224.9	
	225.6	
	224.9	
	224.9	
8.4	233.3	
3.0	228.6	
9.8	234.9	5,084

for Crater Lake.

TABLE 6

2

TABLE 7

TYPICAL SUMMARY OF RESERVOIR OPERATION
LONG LAKE TO ELEVATION 895
RULE CURVE OPERATION

YEAR	INFLOW	END OF YEAR Reservoir Content	POOL ELEVATION			ENERGY	
	1000's of Acre-Feet		Feet Above MSL			Millions of Kilow	
			Maximum	Minimum	Average	Fire	Secondary
1983	299	441.7	895	829	866	224.9	20.3
1984	344	461.5	895	819	860	225.6	18.0
1985	326	458.6	895	828	866	224.9	20.2
1986	291	444.5	894	831	863	224.9	4.6
1987	268	409.3	878	820	853	224.9	
1988	291	387.5	860	794	829	225.6	
1989	302	370.7	846	772	814	224.9	
1990	340	391.1	854	766	811	224.9	
1991	358	438.7	883	782	835	224.9	
1992	293	429.7	894	822	858	225.6	
1993	346	467.7	895	828	863	224.9	6.2
1994	332	464.4	895	832	867	224.9	27.2
1995	316	474.0	895	831	867	224.9	6.7
1996	335	443.7	895	835	868	225.6	51.1
1997	284	424.8	888	820	854	224.9	
1998	282	399.8	864	814	842	224.9	
1999	312	397.5	866	776	825	224.9	
2000	292	371.9	852	773	818	225.6	
2001	423	474.0	895	761	820	224.9	3.7
2002	352	453.4	895	832	867	224.9	32.8
2003	336	452.9	895	835	866	224.9	29.1
2004	357	466.9	895	829	866	225.6	30.3
2005	344	447.5	895	835	868	224.9	47.4
2006	298	445.1	885	830	860	224.9	
2007	357	444.8	895	830	865	224.9	42.0
2008	421	474.0	895	832	866	225.6	35.3
2009	357	468.8	895	835	868	224.9	41.9
2010	349	441.8	895	835	868	224.9	33.5
2011	315	455.6	895	819	861	224.9	0.5
2012	329	456.8	895	835	866	225.6	21.4
2013	349	456.9	895	832	867	224.9	38.7
2014	338	463.7	895	834	867	224.9	18.7
2015	252	415.4	888	830	861	224.9	

Page 1 of 2 pages

y / watt	Total Hours	WASTE Non-Usable Acre-Feet
	245.2	
	243.6	
	245.1	4,352
	229.5	
	224.9	
	225.6	
	224.9	
	224.9	
	224.9	
	225.6	
	231.1	
	252.1	1,368
	231.6	
	276.7	
	224.9	
	224.9	
	224.9	
	225.6	
	228.6	
	257.7	31,354
	254.0	
	255.9	4,975
	272.3	2,959
	224.9	
	266.9	3,622
	260.9	46,988
	266.8	9,388
	258.4	34.244
	225.4	
	247.0	
	263.6	
	243.7	8,624
	224.9	

TABLE 7

2

TABLE 7
(cont'd)
TYPICAL SUMMARY OF RESERVOIR OPERATION
LONG LAKE TO ELEVATION 895
RULE CURVE OPERATION

YEAR	INFLOW	END OF YEAR Reservoir Content	POOL ELEVATION Feet Above MSL Maximum	Minimum	Average	E Firm Millions of	Sec
	1000's of Acre-Feet						
2016	266	365.5	861	798	833	225.6	
2017	358	400.6	864	752	805	224.9	
2018	332	422.7	884	786	835	224.9	
2019	296	410.8	861	808	841	224.9	
2020	278	376.5	864	787	830	225.6	
2021	313	366.6	841	759	804	224.9	
2022	308	349.2	835	756	799	224.9	
2023	327	350.8	842	748	799	224.9	
2024	309	327.3	825	738	788	225.6	
2025	343	331.5	822	720	770	224.9	
2026	392	400.3	874	735	801	224.9	
2027	325	413.6	867	738	831	224.9	
2028	311	417.9	883	809	845	225.6	
2029	299	408.6	879	793	838	224.9	
2030	344	444.5	887	791	839	224.9	
2031	326	458.6	895	816	859	224.9	
2032	291	444.5	894	831	863	225.6	
Average					843		
Minimum				720			
Average Annual						225.1	1

NOTE: Starting year 1983 for Long Lake is used to be compatable with the water year 1980 for Cr

ENERGY		WASTE
condary f Kilowatt	Total Hours	Non-Usable Acre-Feet
	225.6	
	224.9	
	224.9	
	224.9	
	225.6	
	224.9	
	224.9	
	224.9	
	225.6	
	224.9	
	224.9	
	224.9	
	225.6	
	224.9	
	224.9	
8.4	233.3	
4.0	229.6	
10.8	35.9	2,957

rater Lake.

TABLE 7

TABLE 8

TYPICAL SUMMARY OF RESERVOIR OPERATION
CRATER LAKE TO ELEVATION 1022
RULE CURVE OPERATION

YEAR	INFLOW	END OF YEAR Reservoir Content	POOL ELEVATION Feet Above MSL			EN	
	1000's of Acre-Feet		Maximum	Minimum	Average	Firm Millions of	Sec
1980	213	106.9	1022	861	950	106.3	[illegible]
1981	134	105.8	1022	916	973	106.0	[illegible]
1982	148	102.7	1022	920	973	106.0	[illegible]
1983	134	103.1	1022	888	959	106.0	[illegible]
1984	149	110.0	1022	901	967	106.3	[illegible]
1985	148	109.9	1022	910	975	106.0	[illegible]
1986	130	104.8	1022	912	969	106.0	[illegible]
1987	113	89.4	996	899	955	106.0	[illegible]
1988	126	81.5	971	854	917	106.3	[illegible]
1989	132	77.5	958	823	899	106.0	[illegible]
1990	154	95.2	985	819	904	106.0	[illegible]
1991	175	110.0	1022	882	960	106.0	[illegible]
1992	117	93.7	1010	919	968	106.3	[illegible]
1993	144	109.9	1022	893	962	106.0	[illegible]
1994	155	110.0	1022	908	974	106.0	[illegible]
1995	143	110.2	1022	905	971	106.0	[illegible]
1996	154	104.1	1022	920	975	106.3	[illegible]
1997	122	98.7	1015	893	954	106.0	[illegible]
1998	120	89.2	980	891	941	106.0	[illegible]
1999	138	96.2	1000	859	926	106.0	[illegible]
2000	131	96.7	1000	862	938	106.3	[illegible]
2001	196	110.0	1022	883	958	106.0	[illegible]
2002	162	107.6	1022	911	973	106.0	[illegible]
2003	159	107.3	1022	920	973	106.0	[illegible]
2004	162	110.0	1022	909	974	106.3	[illegible]
2005	156	105.4	1022	920	976	106.0	[illegible]
2006	131	103.4	1014	910	967	106.0	[illegible]
2007	162	104.3	1022	918	975	106.0	[illegible]
2008	192	110.0	1022	913	972	106.3	[illegible]
2009	162	110.0	1022	919	976	106.0	[illegible]
2010	163	103.0	1022	920	974	106.0	[illegible]

ERGY		WASTE
ondary Kilowatt	Total Hours	Non-Usable Acre-Feet
31.5	137.8	25,203
8.6	114.6	
21.2	127.2	669
6.0	112.0	
13.5	119.8	
15.9	121.9	5,515
8.5	114.5	
1.0	107.0	
	106.3	
	106.0	
	106.0	
15.6	121.6	15,630
6.0	122.3	
2.9	108.9	
18.8	124.8	8,896
15.6	121.6	
28.8	135.1	964
	106.0	
	106.0	
	106.0	
	106.3	
24.4	130.4	27,280
18.5	124.5	18,242
21.2	127.2	1,064
25.4	131.7	3,425
24.8	130.8	6,824
1.6	107.6	
29.0	135.0	7,067
28.4	134.7	28,296
22.8	128.8	10,494
21.1	127.1	20,025

TABLE 8

TABLE 8 (cont'd)

TYPICAL SUMMARY OF RESERVOIR OPERATION
CRATER LAKE TO ELEVATION 1022
RULE CURVE OPERATION

YEAR	INFLOW	END OF YEAR Reservoir Content	POOL ELEVATION Feet Above MSL			EN[illegible]	
	1000's of Acre-Feet		Maximum	Minimum	Average	Firm Millions of	Sec[illegible]
2011	143	108.1	1022	899	968	106.0	[illegible]
2012	151	108.8	1022	920	973	106.3	[illegible]
2013	156	108.8	1022	918	975	106.0	[illegible]
2014	151	110.0	1022	920	975	106.0	[illegible]
2015	113	91.3	1010	908	964	106.0	[illegible]
2016	118	76.6	980	859	926	106.3	
2017	163	103.4	1008	801	900	106.0	
2018	153	104.2	1022	901	968	106.0	[illegible]
2019	127	104.2	999	904	959	106.0	
2020	125	101.1	1022	892	961	106.3	[illegible]
2021	139	106.9	1010	890	955	106.0	[illegible]
2022	137	108.6	1022	914	972	106.0	[illegible]
2023	150	106.8	1022	920	974	106.0	[illegible]
2024	140	106.1	1017	910	970	106.3	[illegible]
2025	158	110.0	1022	914	973	106.0	[illegible]
2026	185	103.9	1022	920	976	106.0	[illegible]
2027	145	110.0	1022	905	969	106.0	[illegible]
2028	149	109.3	1022	915	973	106.3	[illegible]
2029	213	106.9	1022	920	980	106.0	[illegible]
Average					961		
Minimum				801			
Average Annual						106.1	[illegible]

GY		WASTE
dary ilowatt	Total Houts	Non-Usable Acre-Feet
5	116.5	
0	127.3	
8	127.8	4,832
8	125.8	2,539
8	150.8	
	106.3	
	106.0	
8	124.8	5,145
	106.0	
0	107.3	
9	110.9	
1	115.1	
4	128.4	
5	118.8	
2	127.2	4,546
3	152.8	11,785
[illegible]	116.9	
[illegible]	126.7	326
[illegible]	146.7	43,457
		5,088
[illegible]	120.0	

TABLE 8

2

TABLE 9

TYPICAL SUMMARY OF RESERVOIR OPERATION
CRATER LAKE TO ELEVATION 1022

YEAR	INFLOW	END OF YEAR Reservoir Content	POOL ELEVATION Feet Above MSL			Firm Million
	1000's of Acre-Feet		Maximum	Minimum	Average	
1980	213	106.9	1022	861	952	106.3
1981	134	105.8	1022	918	973	106.0
1982	148	102.7	1022	921	979	106.0
1983	134	103.1	1022	888	959	106.0
1984	149	111.6	1022	901	967	106.3
1985	148	110.1	1022	917	979	106.0
1986	130	104.8	1022	921	975	106.0
1987	113	90.3	998	901	956	106.0
1988	126	82.8	973	857	920	106.3
1989	132	79.5	962	828	903	106.0
1990	154	98.3	991	828	910	106.0
1991	175	111.4	1022	891	965	106.0
1992	117	100.1	1022	928	977	106.3
1993	144	109.9	1022	911	973	106.0
1994	155	113.1	1022	922	982	106.0
1995	143	118.5	1022	914	977	106.0
1996	154	104.1	1022	960	1000	106.3
1997	122	98.7	1015	893	954	106.0
1998	120	89.2	980	891	941	106.0
1999	138	96.2	1000	839	926	106.0
2000	131	96.7	1000	862	938	106.3
2001	196	117.3	1022	883	959	106.0
2002	162	107.6	1022	933	988	106.0
2003	159	107.3	1022	927	980	106.0
2004	162	112.7	1022	909	974	106.3
2005	156	105.4	1022	932	984	106.0
2006	131	110.5	1018	910	969	106.0
2007	162	104.3	1022	929	983	106.0
2008	192	116.1	1022	913	975	106.3
2009	162	113.3	1022	943	994	106.0
2010	163	103.0	1022	930	984	106.0
2011	143	108.8	1022	899	969	106.0
2012	151	108.8	1022	924	980	106.3
2013	156	109.1	1022	920	983	106.0
2014	151	114.1	1022	921	978	106.0
2015	113	97.7	1022	919	974	106.0

...ERGY		WASTE
...ondary Kilowatt	Total Hours	Non-Usable Acre-Feet
...2.1	128.4	36,722
...8.7	114.7	
...8.1	124.1	6,164
...6.0	112.0	
...2.1	118.4	
...7.6	123.6	5,515
...9.5	115.5	
	106.0	
	106.3	
	106.0	
	106.0	
...7.8	123.8	15,630
...2.9	109.2	
...9.4	115.4	
...7.1	123.1	8,896
...1.9	117.9	
...9.2	135.5	13,074
	106.0	
	106.0	
	106.0	
	106.3	
...8.0	124.0	27,280
...9.3	125.3	26,970
...6.2	122.2	8,007
...3.1	129.4	5,425
...4.9	130.9	10,964
	106.0	
...5.3	131.3	15,264
...0.6	126.9	31,832
...4.1	130.1	15,269
...0.2	126.2	26,313
...0.2	116.2	
...4.7	121.0	9,487
...6.6	122.6	12,595
...6.9	122.9	2,539
...3.8	109.8	

TABLE 9

2

TABLE 9 (cont'd)

TYPICAL SUMMARY OF RESERVOIR OPERATION
CRATER LAKE TO ELEVATION 1022

YEAR	INFLOW	END OF YEAR Reservoir Content	POOL ELEVATION Feet Above MSL			E
	1000's of Acre-Feet		Maximum	Minimum	Average	Firm Millions
2016	118	85.7	997	881	944	106.3
2017	163	111.0	1022	842	927	106.0
2018	153	104.2	1022	922	981	106.0
2019	127	104.2	999	904	959	106.0
2020	125	101.1	1022	892	961	106.3
2021	139	112.8	1021	890	958	106.0
2022	137	111.0	1022	930	983	106.0
2023	150	106.8	1022	934	989	106.0
2024	140	108.5	1022	910	975	106.3
2025	158	111.7	1022	920	978	106.0
2026	185	103.9	1022	937	989	106.0
2027	145	113.5	1022	905	970	106.0
2028	149	109.3	1022	940	988	106.3
2029	213	106.9	1022	932	987	106.0
Average					967	
Minimum				828		
Average Annual						106.1

ERGY		WASTE
ondary Kilowatt	Total Hours	Non-Usable Acre-Feet
	106.3	
5.4	111.4	
4.2	130.2	8,577
	106.0	
1.0	107.3	
	106.0	
2.0	118.0	1,695
0.7	126.7	7,707
1.6	117.9	
9.3	125.3	8,424
3.7	139.7	31,826
7.9	113.9	
5.2	121.5	12,122
3.1	109.1	56,390
2.4	118.5	8,107

TABLE 9
(cont'd)

TABLE 10

SUMMARY OF FINAL STUDIES

Lake	Operation	Pool Elevation Maximum	Pool Elevation Minimum	Pool Elevation Average	Maximum Drawdown (ft)	Design Head 1/ (ft)	Minimum Pool % Design Head	Maximum Reqrd Disch cfs
		Elevation (ft MSL)						
Long	Normal	895	719.8	845.2	175.2	845.2	85.2	980
Long	Rule Curve	895	819.8	843.5	175.2	843.5	85.3	980
Crater	Normal	1022	827.8	967.4	194.2	967.4	85.6	400
Crater	Rule Curve	1022	801.4	960.7	220.6	960.7	83.4	410

1/ Design Head is equal to average head.

Waste Average Annual AF	Active Storage AF	Energy Average Annual Primary KWH	Energy Average Annual Secondary KWH	Dependabl Capacity KW
5,084	252,000	225,000,000	9,800,000	46,700
2,957	252,000	225,000,000	10,800,000	46,700
8,107	81,000	106,000,000	12,400,000	23,350
5,088	88,500	106,000,000	13,900,000	23,350

TABLE 10

TABLE 11

SNETTISHAM UNIT CRITERIA

Item	Long Lake	Crater Lake
Installed (KW) 1/	40,600 (2 units)	20,300
Primary Energy (KWH)	225×10^6	106×10^6
Dependable Capacity w/overload (KW)	46,700	23,350
Maximum Pool (ft msl)	895	1022
Minimum Pool (ft msl)	720	828
Average Pool (ft msl)	845	967
Minimum TW (ft msl) 2/	-1.0	-1.0
Maximum TW (ft msl)	16.0	16.0
Power Factor 3/	0.9	0.9
Load Factor	0.55	0.52 4/
Maximum Q (cfs - normal operation)	930	410
Maximum Q (cfs - 2 unit operation)	-	530 5/

1/ Units were made equal size as per USBR letter of 29 Mar 65, exhibit 6.

2/ Minimum tailwater established by a sill assumed to be at elevation -1.0

3/ Power factor is as requested in USBR letter of 1 Apr 65, exhibit 7.

4/ Load factor (annual) for Long Lake is the same as used in the authorizing documents; however, the requirement for units of equal size (exhibit 6) changes Crater Lake to approximately 52%.

5/ This flow would be required only for peaking (early summer peak - 34000 KW) during closure of Long Lake penstock. Increased hydraulic losses could be tolerated for peaking during the short period of closure.

TABLE 12

DETAIL RESULTS - ALL PRELIMINARY STUDIES

Lake	Pool Elevations Maximum	Minimum Elevation (ft MSL)	Average	Maximum Drawdown (feet)	Primary	Millions of KWH
Long	815.0	687.0	780.3	128.0	185.1	27.3
	815.0	663.1	775.6	151.9	190.1	22.0
	815.0	643.4	770.5	171.6	192.6	19.1
	900.0	784.3	868.7	115.7	218.4	20.4
	900.0	771.0	862.3	129.0	222.7	16.7
	900.0	734.0	850.5	166.0	225.2	12.4
	950.0	850.8	919.4	99.2	237.7	17.6
	950.0	844.2	915.4	105.8	240.2	14.4
	950.0	796.7	903.3	153.3	242.6	9.8
	1020.0	942.2	1001.5	77.8	250.2	26.0
	1020.0	941.1	997.9	78.9	255.2	20.9
	1020.0	926.4	991.2	93.6	260.2	15.8
	1020.0	876.0	975.0	144.0	263.0	7.5
Crater	1020.0	860.8	984.8	159.2	94.8	20.7
	1020.0	852.9	979.4	167.1	99.8	18.2
	1020.0	845.0	970.0	175.0	104.8	13.2
	1120.0	1012.8	1093.1	107.2	109.8	20.2
	1120.0	1009.6	1089.3	110.4	114.8	17.2
	1120.0	992.7	1083.8	127.3	120.1	14.7
	1120.0	952.8	1077.6	167.2	122.6	12.5
	1220.0	1141.1	1197.8	78.9	119.8	22.5
	1220.0	1139.0	1195.2	81.0	124.7	19.6
	1220.0	1135.4	1191.8	84.6	129.7	15.9
	1220.0	1105.1	1187.0	114.9	133.0	11.4
Combined	860.0	723.4	823.7	136.6	282.7	41.6
	860.0	716.9	822.3	143.1	285.2	39.4
	860.0	710.1	820.7	149.9	287.7	37.1
	860.0	702.3	818.7	157.7	290.2	34.5
	860.0	693.3	814.0	166.7	293.2	30.8
	860.0	690.4	812.4	169.6	294.2	30.0
	900.0	741.7	854.0	158.3	316.2	26.2
	900.0	738.0	853.4	162.0	317.2	25.25
	900.0	734.2	851.6	165.8	318.2	23.4
	950.0	825.8	911.6	124.2	341.2	25.5
	950.0	828.8	910.7	126.2	342.2	24.5
	950.0	818.6	908.5	131.4	344.2	22.0
	950.0	796.1	899.3	153.9	346.2	17.3
	1020.0	935.3	994.0	84.7	375.2	25.0
	1020.0	930.5	990.9	89.5	377.7	22.5
	1020.0	928.2	990.0	91.8	380.2	19.5
	1020.0	905.0	983.2	115.0	381.3	15.7

Total	Capacity Installed	Dependable
	KW	
212.4	38,400	43,700
212.1	39,500	44,700
211.7	40,000	45,100
238.8	45,300	51,800
239.4	46,200	52,700
237.6	46,700	53,000
253.3	49,300	56,500
254.6	49,800	57,000
252.4	50,400	57,200
276.2	51,900	59,300
276.1	52,900	60,500
276.0	54,000	61,700
270.5	55,000	62,600
115.5	19,700	22,300
118.0	20,700	23,500
118.0	21,800	24,700
130.0	22,800	26,000
132.0	23,800	27,200
134.8	24,900	28,400
135.1	25,400	28,900
142.3	25,000	28,700
144.3	25,900	29,700
145.6	26,900	30,900
144.4	27,600	31,600
324.3	58,600	66,600
324.6	59,100	67,100
324.8	59,700	67,700
324.7	60,200	68,200
324.0	60,800	68,700
324.2	61,100	69,100
342.4	65,600	74,300
342.45	65,800	74,600
341.6	66,000	74,800
366.7	70,800	80,600
366.7	71,000	80,900
366.2	71,400	81,100
363.5	71,850	81,600
400.2	77,900	89,000
400.2	78,400	89,700
400.0	78,900	90,200
397.0	79,100	90,300

TABLE 12

TABLE 13

Summary of Selected Preliminary Studies
All Alternative Plans

	Maximum Pool Elevation Ft MSL	Minimum Pool Elevation Ft MSL	Average Pool Elevation Ft MSL	Maximum Drawdown Ft	Design Head Ft	Minimum Pool % Design Head	Maximum Required Discharg[e] CFS
Long	815	643.4	770.5	171.6	768	83.7	1000
	900	734.0	850.5	166.0	848	86.5	1025
	950	796.7	903.5	153.3	901	88.4	1015
	1020	876.0	975.0	144.0	973	90.0	1000
Crater	1020	845.0	970.0	175.0	968	87.3	415
	1120	952.8	1077.6	167.2	1075	88.6	430
	1220	1105.1	1187.5	115.0	1185	93.2	400
Combined Lakes	860	690.4	812.4	169.6	810	84.9	1420
	900	739.5	851.6	160.5	849	86.2	1450
	950	796.1	899.3	153.9	897	88.8	1450
	1020	905.0	983.7	115.0	981	92.7	1410
	Project Document Plan						
Long	815	647	764.0	168.0	762	84.9	
Crater	1022	820	955.0	202.0	953	86.0	
Totals for Project Document Plan							
Combined Lakes	860						

Waste	Active Storage	Primary	Secondary	Dependable Capacity
AF	AF	KWH	KWH	KW
7000	193000	192.6	19.1	45100
3040	244000	225.2	12.4	53000
2100	278000	242.6	9.8	57200
1850	350000	263.0	7.5	62000
4910	75000	104.8	13.2	24700
1880	98000	122.6	11.4	31600
1500	98000	133.0	11.4	31600
11000	264000	294.2	29.9	68900
6900	285000	318.2	23.4	74800
4020	335000	346.2	17.3	81700
3690	348000	381.3	15.7	90600
10230	186500	180.0	13.9	
8160	84000	100.0	9.4	
18390	270500	280.0	23.3	
11000	264000	294.2	29.9	

TABLE 13

TABLE 14

INSTALLATION SCHEDULE

Item	Project and System Operational Conditions		
	1st Stage		2nd Stage
Period	1970-1971	1972-1978	1979-1980
Units Installed	1	2	3
Rated Capacity KW 1/	20,300	40,600	60,900
Plant Capacity KW	23,350	46,700	70,000
Average Prime Energy millions KWH 2/	82	161	331
Average Load Factor, percent	50	51	55
Annual Secondary Energy, millions KWH 3/	128	114	22.2

1/ Equal sized units

2/ Average is reflected in demand not plant capability

3/ Reflects average available during growth period

NOTE: Above table shown on Chart 3

TABLE 15
LONG RIVER AT LONG LAKE OUTLET
AVERAGE MONTHLY FLOWS IN CFS

Year	Year of Analysis	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1916	1983	47	46	47	122	239	816	807	1011
1917	1984	83	123	49	63	316	656	940	1218
1918	1985	92	39	25	67	283	703	1011	1152
1919	1986	197	52	47	118	292	515	816	992
1920	1987	170	90	43	49	222	548	867	1133
1921	1988	64	90	65	104	366	675	804	809
1922	1989	86	28	24	110	382	666	861	992
1923	1990	59	80	110	169	412	684	878	919
1924	1991	74	47	85	127	543	859	1105	992
1927	1992	95	76	59	112	432	843	907	912
1928	1993	176	129	114	207	523	770	1020	838
1929	1994	186	40	99	78	329	780	836	790
1930	1995	19	42	57	128	299	672	850	1020
1931	1996	144	250	49	117	462	908	902	1029
1932	1997	52	52	57	102	337	714	775	828
1933	1998	42	38	39	284	509	568	763	788
1934	1999	24	35	48	90	287	805	833	1173
1935	2000	43	28	55	87	263	604	1143	888
1936	2001	46	38	57	142	478	944	892	797
1937	2002	68	44	63	110	312	905	761	875
1938	2003	127	125	135	93	537	704	839	720
1939	2004	92	75	53	102	338	749	1001	1254
1940	2005	74	109	51	146	501	727	944	1162
1941	2006	44	73	64	195	424	807	954	640
1942	2007	98	95	104	120	408	887	1130	1117
1943	2008	110	61	93	219	425	751	1110	982
1944	2009	100	94	107	123	418	982	882	846
1945	2010	53	42	68	114	507	789	973	768
1946	2011	39	44	53	86	592	872	805	963
1947	2012	61	56	159	177	512	864	805	715
1948	2013	107	59	50	64	570	949	905	799
1949	2014	88	44	56	120	503	705	817	894
1950	2015	31	28	39	66	332	727	859	734
1951	2016	49	43	52	101	412	868	954	637
1952	2017	36	36	47	142	415	692	985	905
1953	2018	55	63	46	80	540	891	877	961
1954	2019	67	260	56	47	303	712	771	596
1955	2020	84	52	57	63	270	633	978	1081
1956	2021	28	28	38	66	462	558	964	1278
1957	2022	115	42	33	82	446	756	784	762
1958	2023	182	66	47	142	518	985	925	934
1959	2024	66	66	57	94	403	855	1143	845
1960	2025	86	52	68	139	446	666	986	919
1961	2026	123	119	94	191	479	960	1282	1400
1962	2027	173	74	87	80	288	753	851	787
1963	2028	137	203	103	109	366	699	892	715
1964		118	102	66	147	295	937	1135	805
Monthly Average		88	74	65	117	405	769	922	922

Sep	Oct	Nov	Dec	
982	572	137	82	
872	616	623	89	
1001	476	323	171	
944	497	181	121	
605	360	247	57	
670	650	196	263	
783	450	494	98	
1077	532	492	209	
1020	467	316	264	
907	328	119	47	
785	496	344	297	
712	1020	459	136	
774	518	529	311	
775	651	171	80	
920	660	115	70	
576	511	425	109	
763	661	238	180	
627	619	174	271	
1018	1486	715	367	
1011	1237	246	163	
1149	720	217	183	
786	808	382	246	
946	689	205	108	
471	624	416	203	
866	786	161	107	
1129	1275	425	358	
658	1018	382	277	
930	1284	144	68	
710	589	357	89	
1133	653	257	209	
1141	489	340	125	
839	521	872	124	
909	282	102	50	
699	293	122	86	
1042	1062	420	114	
832	858	135	131	
858	440	444	346	
798	319	200	52	
631	353	410	328	
967	554	424	112	
501	706	240	135	
551	535	259	190	
925	773	317	278	
679	906	194	53	
042	559	383	284	
168	710	120	206	
462	652	255	190	Annual Average
344	664	313	171	448

TABLE 15

2

TABLE 16

CRATER CREEK AT CRATER LAKE OUTLET

AVERAGE MONTHLY FLOWS IN CFS

Year	Year of Analysis	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	S
1913	1980		47	48	57	203	531	830	858	4
1914	1981	21	45	37	53	144	272	517	409	2
1915	1982	36	17	45	74	235	414	497	469	3
1916	1983	18	18	19	44	90	370	370	464	4
1917	1984	35	45	23	24	142	305	441	539	3
1918	1985	33	17	13	21	129	347	482	591	4
1919	1986	68	15	12	47	118	217	417	511	4
1920	1987	100	35	16	20	53	177	406	532	2
1921	1988	24	31	24	34	138	305	399	360	2
1922	1989	34	10	10	35	145	287	437	471	3
1923	1990	21	28	38	47	160	297	452	483	5
1924	1991	28	17	30	39	229	400	584	566	5
1927	1992	35	27	25	38	161	350	377	357	3
1928	1993	89	31	40	42	193	381	528	377	3
1929	1994	76	19	49	29	92	382	419	404	3
1930	1995	5	9	15	34	104	308	420	484	3
1931	1996	68	102	22	45	211	402	417	474	3
1932	1997	20	20	15	33	105	284	362	366	4
1933	1998	14	13	15	66	211	230	379	367	2
1934	1999	7	12	18	31	100	371	420	565	3
1935	2000	15	10	20	30	90	251	606	418	2
1936	2001	16	13	21	42	194	462	454	371	4
1937	2002	26	16	23	35	112	436	379	411	4
1938	2003	55	43	46	32	225	309	423	333	5
1939	2004	37	26	20	33	124	337	520	608	3
1940	2005	28	38	15	43	205	323	485	560	4
1941	2006	15	25	24	51	166	372	491	293	2
1942	2007	40	33	36	37	158	425	538	536	3
1943	2008	45	21	33	56	166	337	585	466	5
1944	2009	41	33	37	38	163	488	448	396	2
1945	2010	19	15	25	36	209	361	502	357	4
1946	2011	13	15	20	30	255	414	403	457	3
1947	2012	23	19	53	48	212	409	403	330	5
1948	2013	44	20	19	25	243	466	461	372	5
1949	2014	35	16	21	37	207	310	410	421	3
1950	2015	10	10	15	25	122	323	436	339	4
1951	2016	17	15	19	33	160	411	489	291	3
1952	2017	12	13	18	42	161	302	511	426	4
1953	2018	20	22	17	29	227	428	446	456	3
1954	2019	25	89	21	20	108	314	384	271	3
1955	2020	33	18	21	24	93	267	506	518	3
1956	2021	9	10	15	25	185	226	497	621	2
1957	2022	48	15	13	29	177	342	392	354	4
1958	2023	84	23	18	42	216	490	474	442	2
1959	2024	25	23	21	32	156	404	606	396	2
1960	2025	34	18	25	41	177	361	511	434	4
1961	2026	52	41	33	52	194	473	691	684	3
1962	2027	79	26	31	29	101	340	431	367	4
1963	2028	59	70	36	35	138	306	454	330	5
1964		50	35	24	43	104	458	599	375	1
Monthly Average		35	27	25	38	160	355	473	446	3

	Oct	Nov	Dec
1	460	108	38
6	313	104	24
9	185	45	33
0	270	51	33
1	251	250	34
1	202	133	65
0	209	67	45
2	140	92	25
7	290	75	95
2	202	158	41
2	230	198	77
1	197	124	95
2	135	48	25
3	194	113	82
7	463	222	60
9	225	256	146
1	334	73	28
9	316	42	27
2	219	170	43
2	296	92	67
6	274	66	97
7	762	294	127
5	615	96	62
5	327	84	68
3	373	151	89
3	311	79	43
2	276	166	75
3	361	61	42
4	637	170	125
1	489	151	99
4	644	55	28
6	258	141	36
5	291	100	77
0	208	134	48
9	224	361	76
3	110	38	22
1	114	46	35
0	515	167	45
6	402	51	51
9	184	178	120
9	126	77	22
8	142	163	115
4	241	169	44
6	320	93	52
0	231	101	71
2	355	125	99
1	428	74	23
0	243	152	101
3	321	45	76
8	291	99	76
3	300	121	63

Annual Average

203

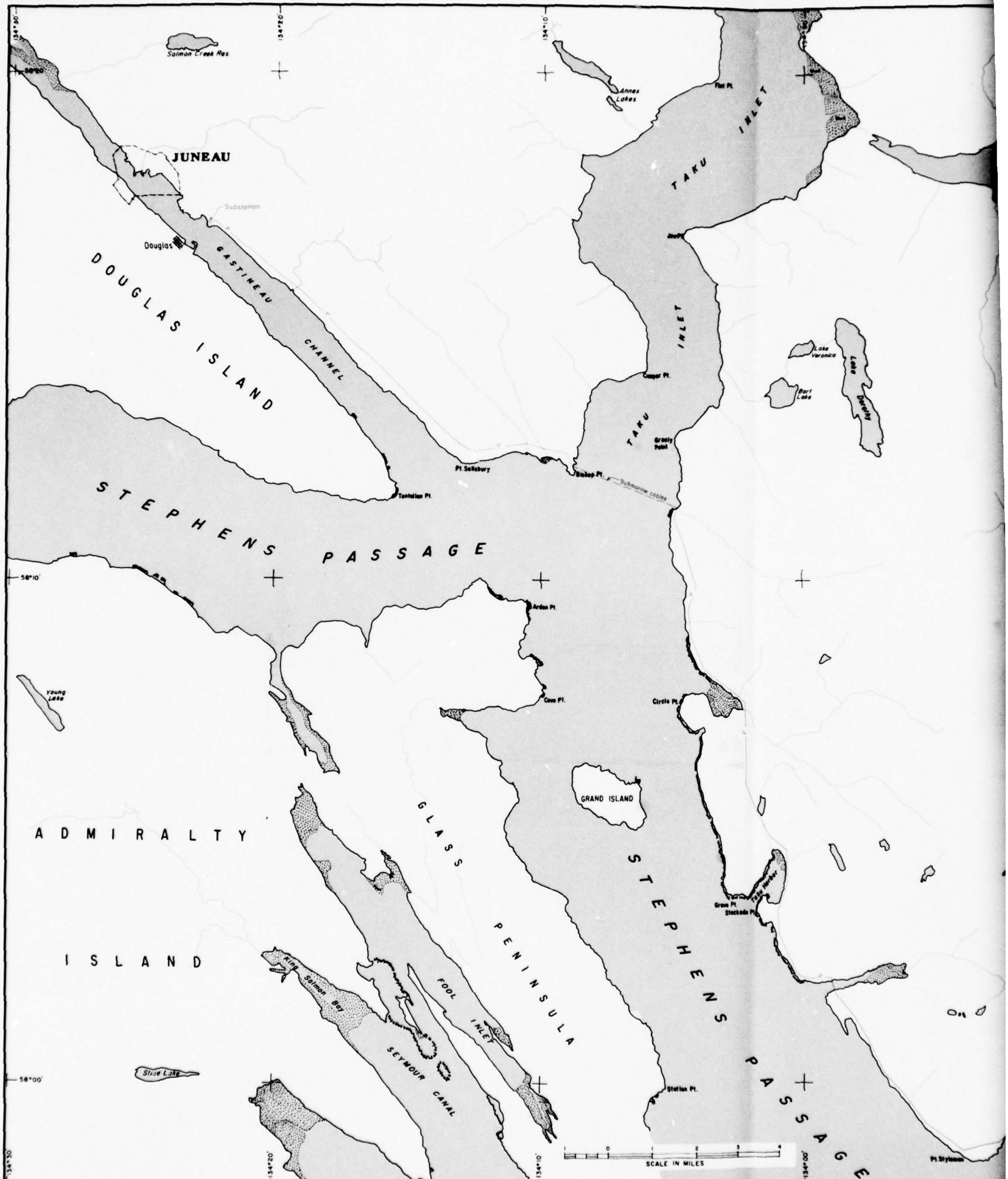
TABLE 16

895-66

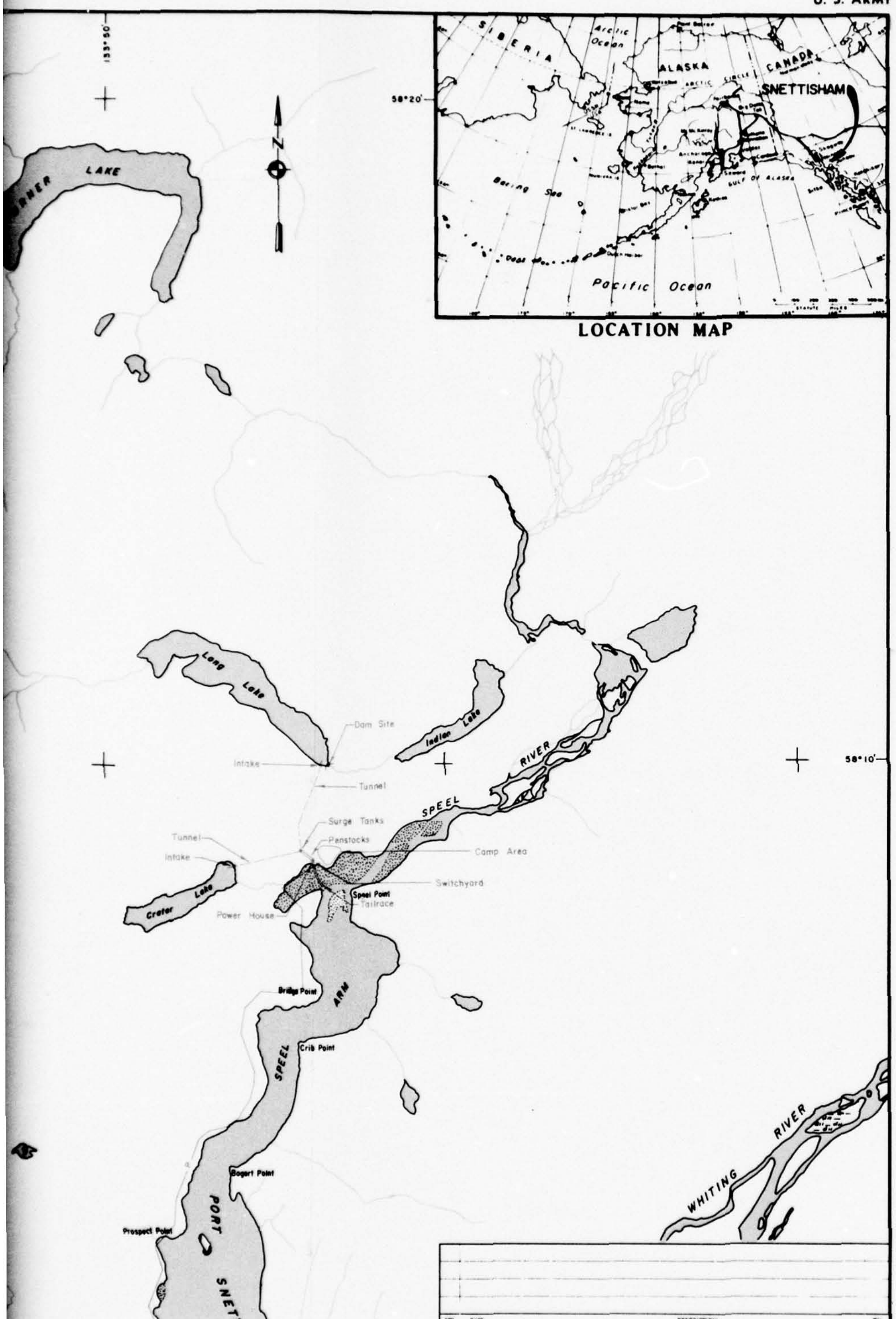
3

PLATES

CORPS OF ENGINEERS



U. S. ARMY



REV	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT. ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

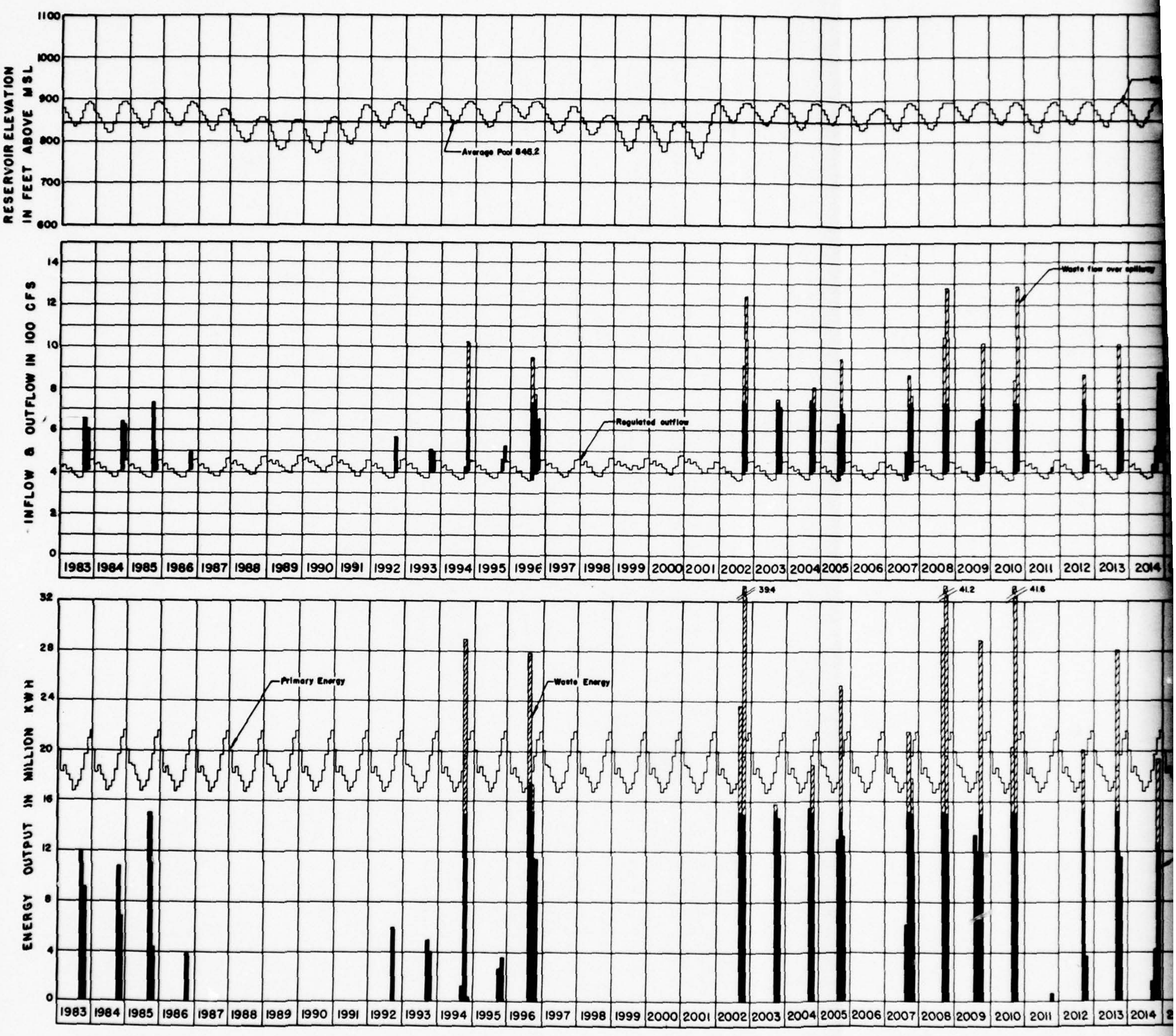
DESIGNED:
DRAWN: E.A.
TRACED: M.D.
CHECKED:
PREPARED:
CHIEF

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

GENERAL AREA

SUPERVISED: W.B. Wacks Jr. P.E.
CHIEF, POWER INVESTIGATIONS SECTION
SUBMITTED:
CHIEF, PLANNING AND REPORTS
RECOMMENDED: Nyal E. Nelson
for CHIEF, ENGINEERING DIVISION

APPROVED: Chas I. Farley
COLONEL, CE DISTRICT ENGINEER
SCALE AS SHOWN
DATE 25 SEPT. 64
FILE NUMBER Q-45-90
SHEET 1 OF 1



LEGEND:

- Waste
- Secondary Energy
- Primary Energy

LONG LAKE

(Maximum pool elevation 895 feet above M.S.L.)

NOTES:

1. Energy demand was a uniform total of 225 million kilowatt hours per year with monthly fluctuations as listed in tabl
2. Usable spill could produce 9.8 million kilowatt hours per average year.
3. Total spill was 13,922 acre-feet per average year.
4. Years are projected into the assumed time of project operation with 1983 equivalent to the first year of period of reco

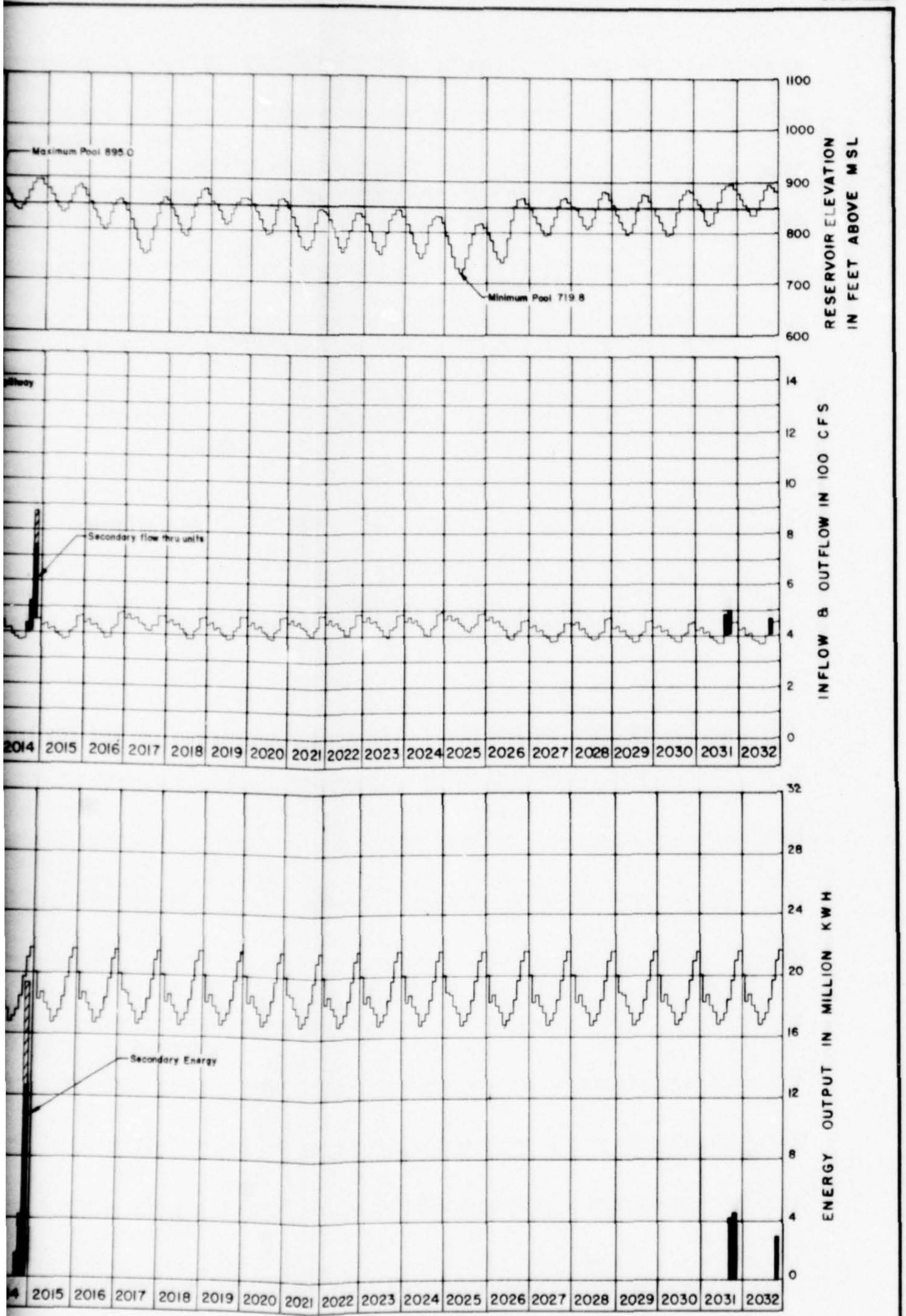


table 4.

record

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

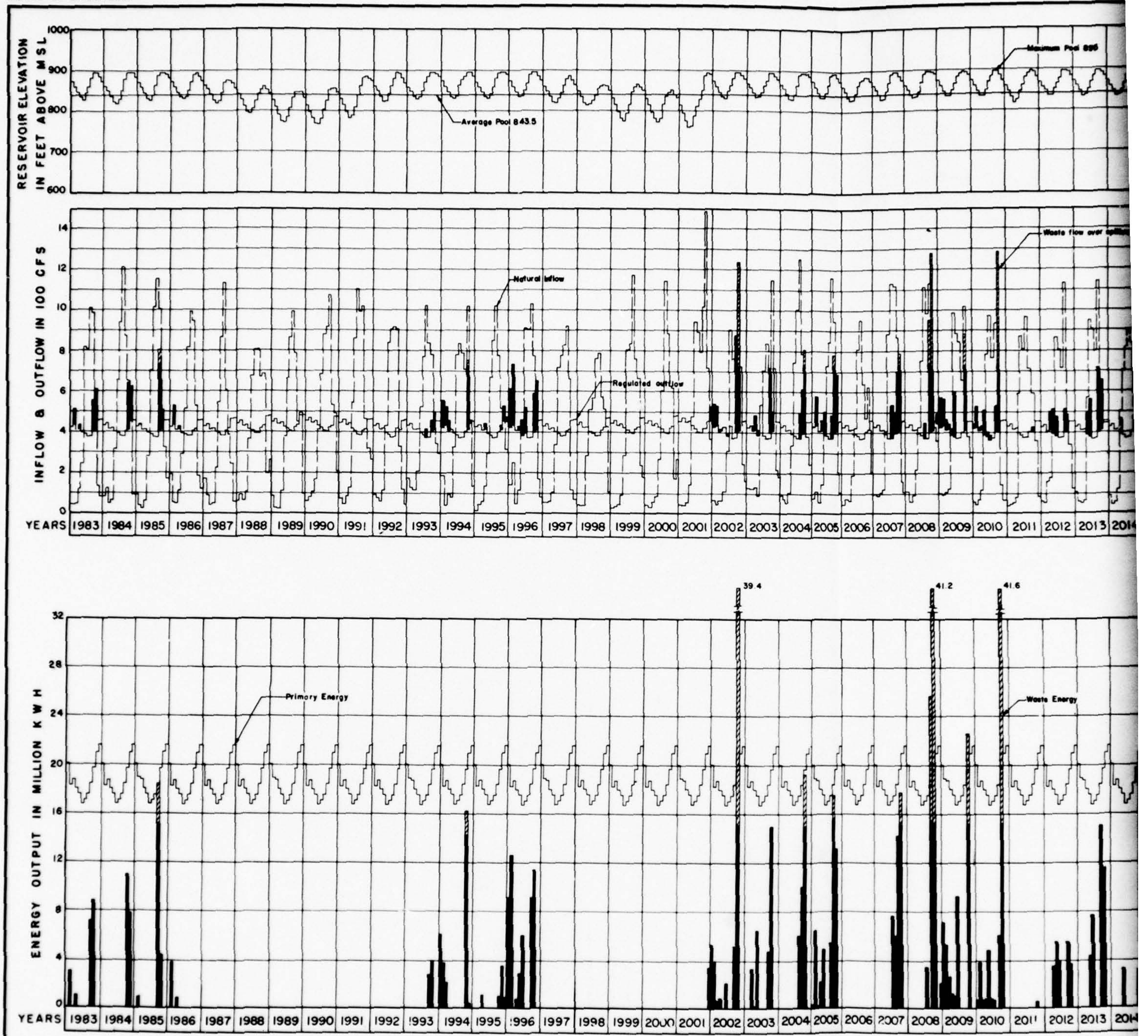
DESIGNED:
DRAWN: L.H.
TRACED:
CHECKED:
PREPARED: R.R.C.

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
LONG LAKE
TYPICAL REGULATION RESULTS

SUPERVISED: M. DeWade Jr.
SUBMITTED:
RECOMMENDED: Warren George

APPROVED: Clar J. Malley
SCALE:
DATE:
FILE NUMBER: Q-4-8-113
SHEET 1 OF 1

22
2



LEGEND

- Waste
- Secondary Energy
- Primary Energy

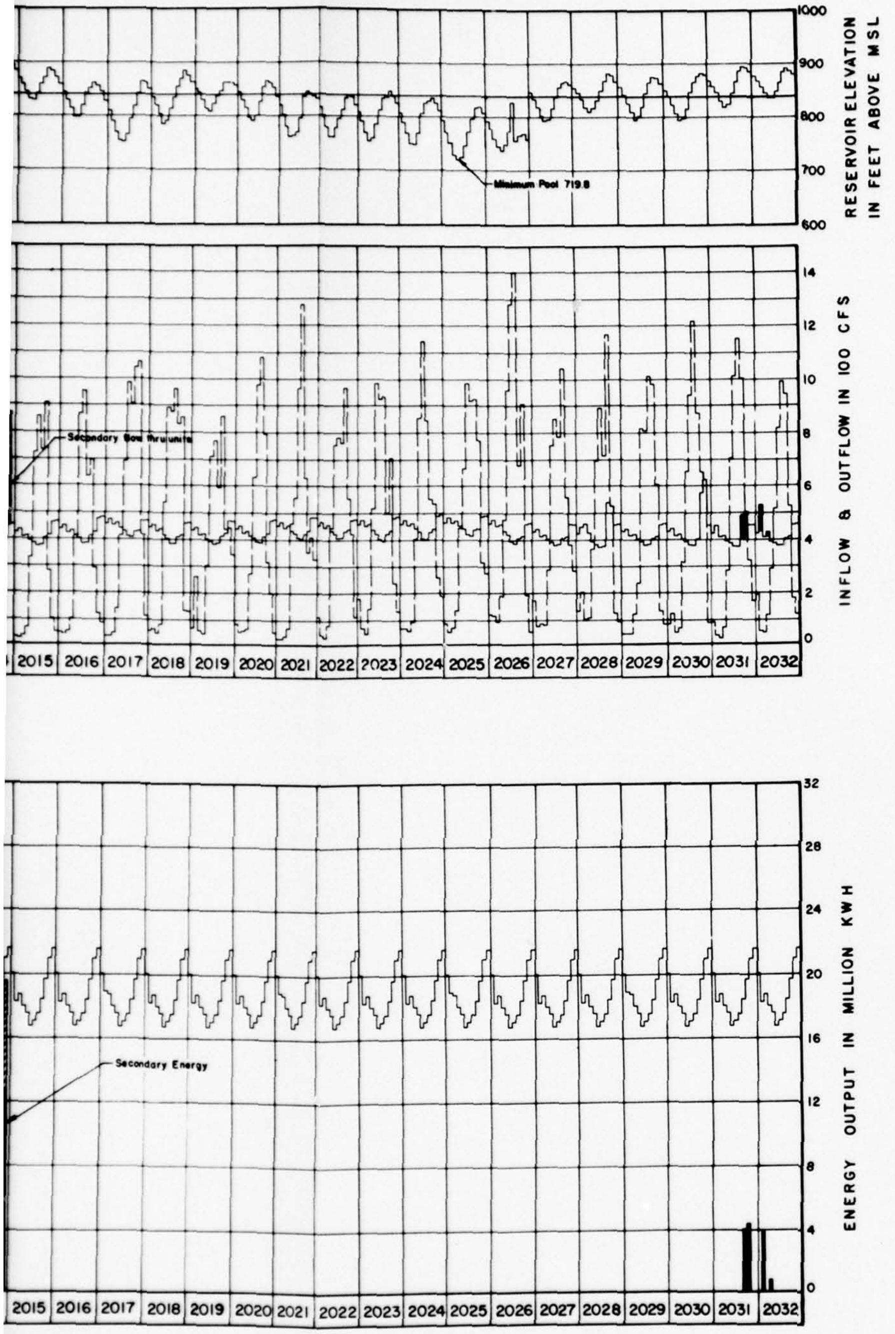
LONG LAKE

(Maximum pool elevation 895 feet above M.S.L.)
w/ rule curve operation

NOTES:

1. Energy demand was a uniform total of 225 million kilowatt hours per year with monthly fluctuations as listed in
2. Useable spill could produce 10.8 million killowatt hours per average year with rule curve operation.
3. Total spill was 15,547 acre-feet per average year.
4. Years are projected into the assumed time of project operation with 1983 equivalent to the first year of period of

U. S. ARMY



...able 4.

...cord.

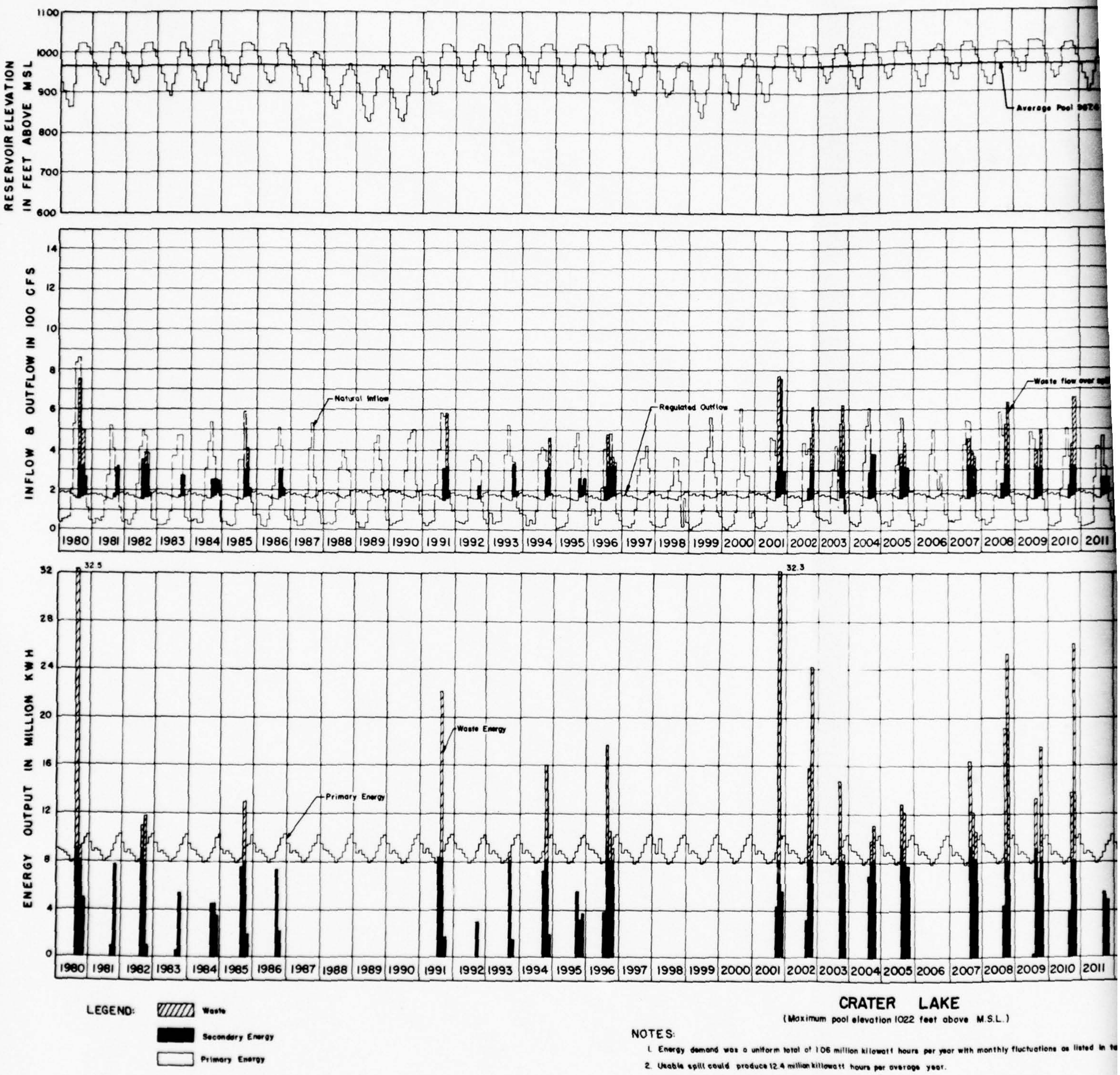
U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: T.S.
TRACED:
CHECKED:
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
LONG LAKE
TYPICAL REGULATION RESULTS

SUPERVISED:
SUBMITTED:
RECOMMENDED:
APPROVED:
SCALE: AS SHOWN
DATE: 31 JULY 1968
FILE NUMBER: Q-4-5-113
SHEET 2 OF 2

ESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 3



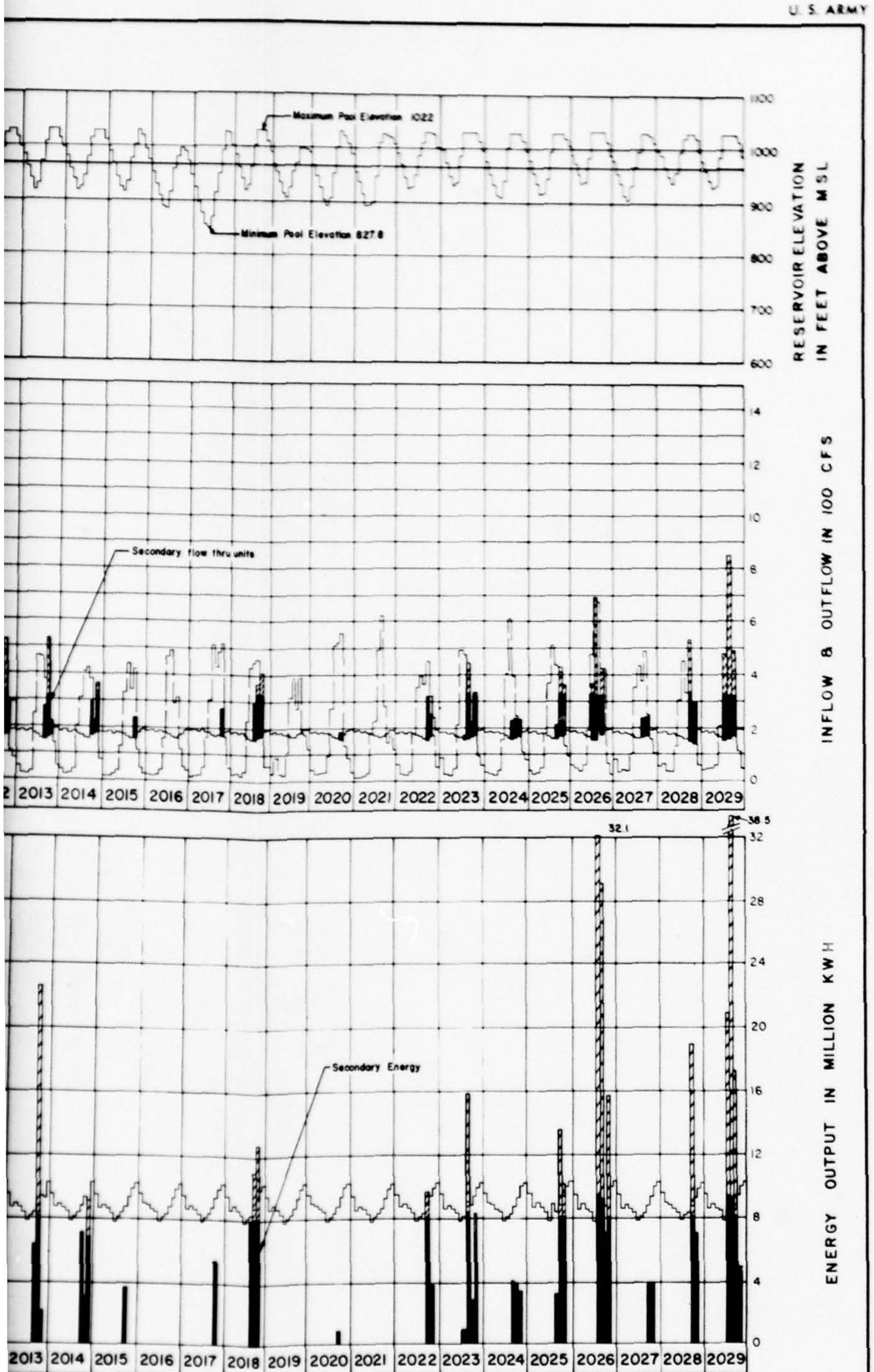
CRATER LAKE

(Maximum pool elevation 1022 feet above M.S.L.)

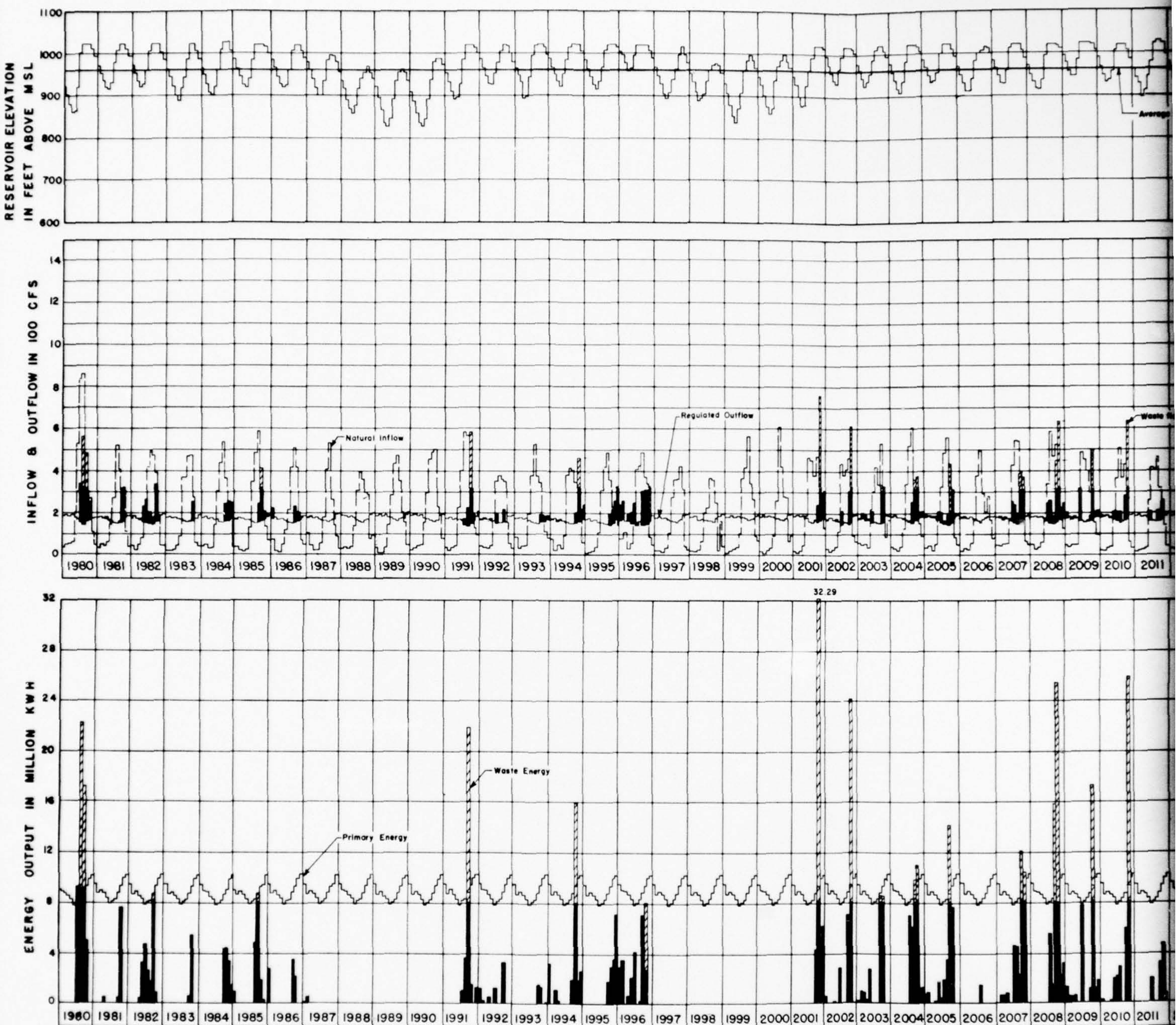
NOTES:

1. Energy demand was a uniform total of 106 million kilowatt hours per year with monthly fluctuations as listed in ta
2. Usable spill could produce 12.4 million kilowatt hours per average year.
3. Total spill was 13922 acre-feet per average year.
4. Years are projected into the assumed time of project operation with 1980 equivalent to the first year of period of re

U. S. ARMY



U. S. ARMY ENGINEER DISTRICT ALASKA CORPS OF ENGINEERS ANCHORAGE ALASKA	
DESIGNED: DRAWN: K.H. CHECKED: PREPARED: LRL	SNETTISHAM PROJECT, ALASKA FIRST STAGE DEVELOPMENT **CRATER LAKE** **TYPICAL REGULATION RESULTS**
SUPERVISED: [signature] CHIEF, POWER INVESTIGATIONS SECTION	APPROVED: [signature] COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: [signature] CHIEF, PLANNING AND REPORTS	SCALE AS SHOWN — DATE 31 JULY 1965
RECOMMENDED: [signature] CHIEF, ENGINEERING DIVISION	SHEET 1 OF 2 — FILE NUMBER Q-4-5-113



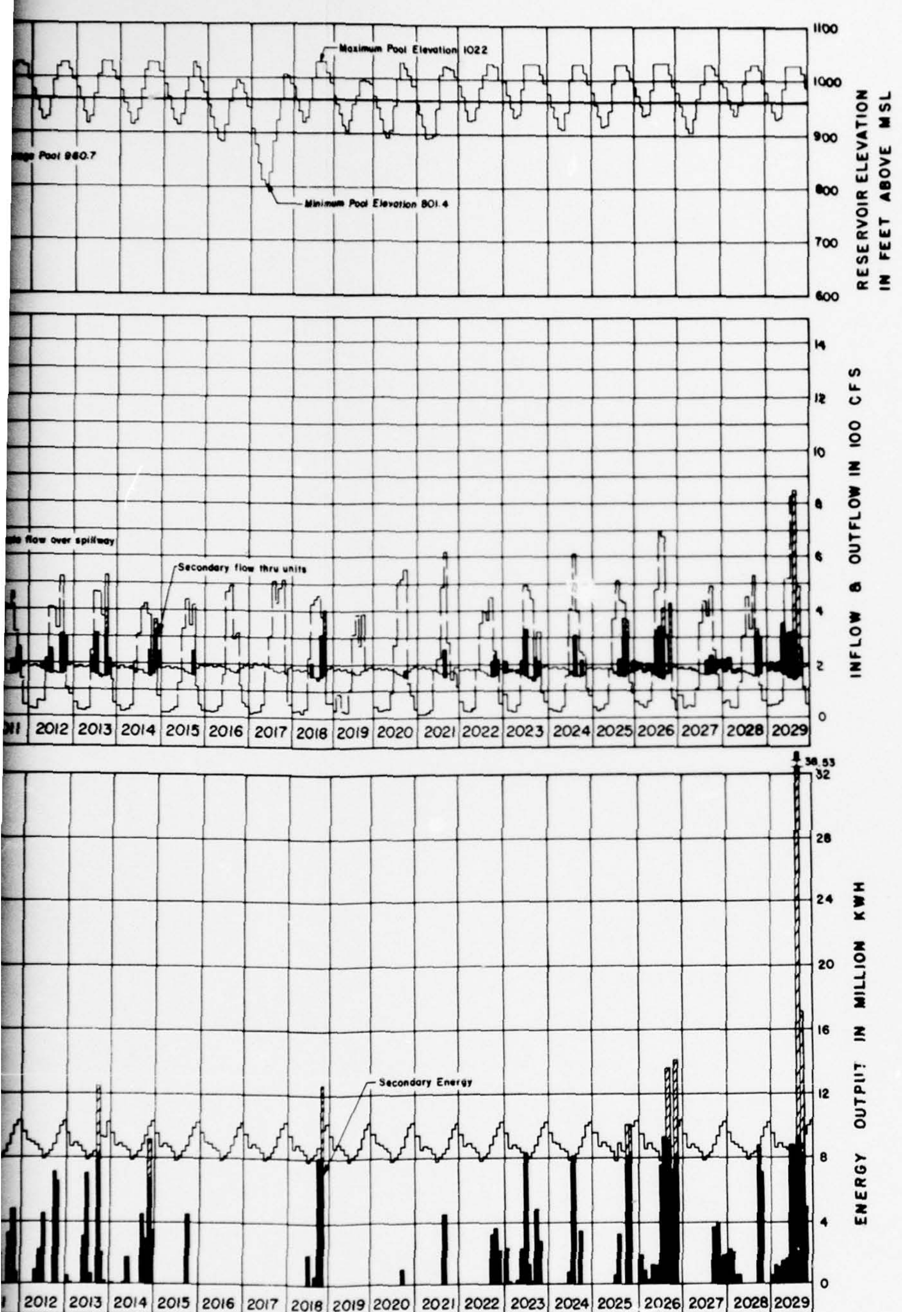
LEGEND:
- Waste
- Secondary Energy
- Primary Energy

CRATER LAKE

(Maximum pool elevation 1022 feet above M.S.L.)
Rule curve operation

NOTES:

1. Energy demand was a uniform total of 106 million kilowatt hours per year with monthly fluctuations as listed in t
2. Usable spill could produce 13.9 million killowatt hours per average year.
3. Total spill was 16,065 acre-feet per average year.
4. Years are projected into the assumed time of project operation with 1980 equivalent to the first year of period of re



...n table 4.

...f record.

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:	SNETTISHAM PROJECT, ALASKA
DRAWN: T.S	FIRST STAGE DEVELOPMENT
CHECKED:	CRATER LAKE
PREPARED: RER	TYPICAL REGULATION RESULTS
SUPERVISED: W. O. Wade Jr. CHIEF, POWER INVESTIGATIONS SECTION	APPROVED: Chas. T. Darley COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: [signature] CHIEF, PLANNING AND REPORTS	SCALE AS SHOWN — DATE 31 JULY 1966
RECOMMENDED: [signature] CHIEF, ENGINEERING DIVISION	SHEET 2 OF 2 — FILE NUMBER Q-4-5-113

	FLOW		ELEVATION		HEAD	STORAGE	SECONDARY		PRIMARY				WASTE	TAIL WATER
	NATL	REG	AVERAGE	EOM	AVERAGE	EOM	SPILL	ENERGY	ENERGY	POWER	KW/CFS	KWH/AF		
	CFS	CFS	FTMSL	FTMSL	FT	AF	AF	KWH	KWH	KW			AF	
PROJECT NO 1				YEAR OF STUDY 1983										
JAN	47.	425.	880.80	874.46	880.31	444028.	0.	0.	20043300.	26940.	63.32	766.	0.	.4
FEB	46.	435.	868.45	862.44	867.95	422394.	0.	0.	18265400.	27180.	62.40	755.	0.	.4
MAR	47.	410.	856.23	850.03	855.75	400055.	0.	0.	18783000.	25246.	61.52	744.	0.	.4
APR	122.	412.	844.31	838.59	843.83	382751.	0.	0.	18041100.	25057.	60.70	734.	0.	.4
MAY	239.	393.	835.62	832.64	835.15	373238.	0.	0.	17591400.	23644.	60.04	726.	0.	.4
JUN	816.	385.	840.96	849.27	840.50	398844.	0.	0.	16781000.	23307.	60.45	731.	0.	.4
JUL	807.	373.	856.72	864.17	856.27	425518.	0.	0.	17096000.	22978.	61.57	745.	0.	.4
AUG	1011.	375.	874.74	885.31	874.28	464619.	0.	0.	17546200.	23583.	62.87	760.	0.	.4
SEP	982.	656.	890.15	895.00	888.69	484000.	15206.	11820600.	18446000.	25619.	64.05	775.	0.	1.4
OCT	605.	604.	895.00	895.00	893.90	484000.	11860.	9223290.	19705200.	26485.	64.26	777.	0.	1.0
NOV	137.	456.	890.24	885.48	889.70	464978.	0.	0.	21032600.	29212.	63.96	773.	0.	.5
DEC	82.	459.	879.34	873.19	878.80	441743.	0.	0.	21618100.	29056.	63.18	764.	0.	.5
PROJECT NO 1				YEAR OF STUDY 1984										
JAN	83.	[illegible]2.	867.22	861.25	866.73	420266.	0.	0.	20043300.	26940.	62.31	754.	0.	.4
FEB	123.	441.	856.16	851.07	855.66	401929.	0.	0.	18917700.	27180.	61.52	744.	0.	.4
MAR	49.	416.	843.77	836.46	843.29	379349.	0.	0.	18783000.	25246.	60.65	733.	0.	.4
APR	63.	420.	829.69	822.91	829.20	358078.	0.	0.	18041100.	25057.	59.59	721.	0.	.4
MAY	316.	401.	821.04	819.16	820.57	352836.	0.	0.	17591400.	23644.	58.92	712.	0.	.4
JUN	656.	393.	824.41	829.65	823.94	368446.	0.	0.	16781000.	23307.	59.20	716.	0.	.4
JUL	940.	380.	840.62	851.58	840.16	402855.	0.	0.	17096000.	22978.	60.40	730.	0.	.4
AUG	1218.	378.	865.90	880.22	865.45	454449.	0.	0.	17546200.	23583.	62.24	753.	0.	.4
SEP	872.	401.	887.37	894.51	886.90	482436.	0.	0.	18446000.	25619.	63.78	771.	0.	.4
OCT	652.	626.	894.75	895.00	893.50	484000.	13170.	10240300.	19705200.	26485.	64.23	777.	0.	1.2
NOV	623.	622.	895.00	895.00	893.77	484000.	10007.	7781180.	21032600.	29212.	64.23	777.	0.	1.2
DEC	89.	454.	889.37	883.75	888.85	461514.	0.	0.	21618100.	29056.	63.90	773.	0.	.5
PROJECT NO 1				YEAR OF STUDY 1985										
JAN	92.	426.	878.24	872.73	877.75	440923.	0.	0.	20043300.	26940.	63.10	763.	0.	.4
FEB	39.	436.	866.60	860.47	866.10	418848.	0.	0.	18265400.	27180.	62.27	753.	0.	.4
MAR	25.	411.	853.69	846.92	853.21	395082.	0.	0.	18783000.	25246.	61.34	742.	0.	.4
APR	67.	414.	840.14	833.36	839.66	374384.	0.	0.	18041100.	25057.	60.40	730.	0.	.4
MAY	283.	395.	831.19	829.02	830.72	367440.	0.	0.	17591400.	23644.	59.71	722.	0.	.4
JUN	703.	388.	834.92	840.82	834.45	386147.	0.	0.	16781000.	23307.	59.97	725.	0.	.4
JUL	1011.	375.	852.42	864.02	851.96	425248.	0.	0.	17096000.	22978.	61.26	741.	0.	.4
AUG	1152.	374.	876.78	889.53	876.32	473074.	0.	0.	17546200.	23583.	63.02	762.	0.	.4
SEP	1001.	728.	892.26	895.00	890.23	484000.	19528.	15171400.	18446000.	25619.	64.10	775.	5299.	2.0
OCT	504.	503.	895.00	895.00	894.36	484000.	5661.	4404740.	19705200.	26485.	64.29	778.	0.	.6
NOV	323.	455.	893.41	891.83	892.88	476144.	0.	0.	21032600.	29212.	64.19	776.	0.	.5
DEC	171.	455.	887.07	882.31	886.54	458630.	0.	0.	21618100.	29056.	63.74	771.	0.	.5
PROJECT NO 1				YEAR OF STUDY 1986										
JAN	197.	426.	878.51	874.71	878.02	444493.	0.	0.	20043300.	26940.	63.10	763.	0.	.4
FEB	52.	435.	868.80	862.89	868.30	423202.	0.	0.	18265400.	27180.	62.42	755.	0.	.4
MAR	47.	41[illegible].	856.68	850.48	856.20	400876.	0.	0.	18783000.	25246.	61.55	744.	0.	.4
APR	118.	412.	844.72	838.96	844.24	383347.	0.	0.	18041100.	25057.	60.[illegible]3	734.	0.	.4
MAY	292.	393.	837.02	835.08	836.56	377136.	0.	0.	17591400.	23644.	60.[illegible]6	727.	0.	.4
JUN	515.	387.	837.45	839.83	836.99	384731.	0.	0.	16781000.	23307.	60.[illegible]7	728.	0.	.4
JUL	816.	376.	848.17	856.51	847.71	411725.	0.	0.	17096000.	22978.	60.[illegible]5	737.	0.	.4
AUG	992.	378.	866.99	877.47	866.53	449450.	0.	0.	17546200.	23583.	62.31	754.	0.	.4
SEP	944.	402.	885.88	894.28	885.41	481681.	0.	0.	18446000.	25619.	63.67	770.	0.	.4
OCT	526.	488.	894.64	895.00	894.02	484000.	4686.	3646200.	19705200.	26485.	64.28	777.	0.	.6
NOV	181.	456.	890.90	886.80	890.37	467617.	0.	0.	21032600.	29212.	64.01	774.	0.	.5
DEC	121.	458.	881.41	876.02	880.87	446847.	0.	0.	21618100.	29056.	63.33	766.	0.	.5
PROJECT NO 1				YEAR OF STUDY 1987										
JAN	170.	430.	871.58	867.13	871.09	430841.	0.	0.	20043300.	26940.	62.60	757.	0.	.4
FEB	90.	438.	861.75	856.36	861.25	412462.	0.	0.	18265400.	27180.	61.92	749.	0.	.4
MAR	43.	413.	849.49	842.62	849.01	388671.	0.	0.	18783000.	25246.	61.02	738.	0.	.4
APR	49.	417.	835.61	828.59	835.13	366755.	0.	0.	18041100.	25057.	60.04	726.	0.	.4
MAY	222.	399.	824.96	821.33	824.49	355870.	0.	0.	17591400.	23644.	59.25	716.	0.	.4
JUN	548.	393.	824.43	827.53	823.97	365054.	0.	0.	16781000.	23307.	59.20	716.	0.	.4
JUL	867.	382.	837.16	846.79	836.70	394872.	0.	0.	17096000.	22978.	60.14	727.	0.	.4
AUG	1133.	381.	859.80	872.81	859.34	441073.	0.	0.	17546200.	23583.	61.80	747.	0.	.4
SEP	605.	406.	876.09	879.36	875.61	452861.	0.	0.	18446000.	25619.	62.96	761.	0.	.4
OCT	381.	419.	878.71	878.06	878.22	450508.	0.	0.	19705200.	26485.	63.17	764.	0.	.4
NOV	247.	464.	874.45	870.85	873.90	437537.	0.	0.	21032600.	29212.	62.82	760.	0.	.5
DEC	57.	468.	863.83	856.81	863.26	412257.	0.	0.	21618100.	29056.	62.06	751.	0.	.5
PROJECT NO 1				YEAR OF STUDY 1988										
JAN	64.	441.	849.85	842.90	849.35	389060.	0.	0.	20043300.	26940.	61.05	738.	0.	.4
FEB	90.	452.	836.20	829.51	835.68	368219.	0.	0.	18917700.	27180.	60.09	727.	0.	.5
MAR	65.	427.	821.79	814.08	821.30	345901.	0.	0.	18783000.	25246.	58.98	713.	0.	.4
APR	104.	433.	806.42	798.77	805.93	326282.	0.	0.	18041100.	25057.	57.77	699.	0.	.4
MAY	366.	414.	797.71	796.65	797.23	323310.	0.	0.	17591400.	23644.	57.06	690.	0.	.4
JUN	675.	405.	802.72	808.80	802.25	339328.	0.	0.	16781000.	23307.	57.43	694.	0.	.4
JUL	804.	391.	818.05	827.29	817.58	364674.	0.	0.	17096000.	22978.	58.65	709.	0.	.4
AUG	809.	392.	835.52	843.75	835.06	390257.	0.	0.	17546200.	23583.	60.01	726.	0.	.4
SEP	670.	420.	848.29	852.84	847.81	405117.	0.	0.	18446000.	25619.	60.96	737.	0.	.4
OCT	688.	429.	857.25	861.65	856.76	420986.	0.	0.	19705200.	26485.	61.60	745.	0.	.4
NOV	196.	474.	857.05	852.45	856.47	404412.	0.	0.	21032600.	29212.	61.55	744.	0.	.5
DEC	263.	476.	845.47	844.49	847.88	391285.	0.	0.	21618100.	29056.	60.97	737.	0.	.5
PROJECT NO 1				YEAR OF STUDY 1989										
JAN	84.	447.	837.26	830.03	836.75	369047.	0.	0.	20043300.	26940.	60.17	728.	0.	.5
FEB	28.	460.	821.68	813.34	821.14	345008.	0.	0.	18265400.	27180.	58.97	713.	0.	.5
MAR	24.	438.	803.54	793.75	803.05	319510.	0.	0.	18783000.	25246.	57.54	696.	0.	.4
APR	110.	446.	785.83	777.91	785.33	299497.	0.	0.	18041100.	25057.	56.13	679.	0.	.5
MAY	382.	426.	776.76	775.62	776.27	296746.	0.	0.	17591400.	23644.	55.40	670.	0.	.4
JUN	666.	418.	781.46	787.30	780.97	311491.	0.	0.	16781000.	23307.	55.73	674.	0.	.4
JUL	861.	402.	798.17	809.05	797.70	339678.	0.	0.	17096000.	22978.	57.07	690.	0.	.4
AUG	992.	399.	821.74	834.42	821.27	376079.	0.	0.	17546200.	23583.	58.96	713.	0.	.4
SEP	783.	423.	841.41	848.41	840.93	397457.	0.	0.	18446000.	25619.	60.46	731.	0.	.4
OCT	450.	434.	848.71	849.01	848.21	398425.	0.	0.	19705200.	26485.	60.99	737.	0.	.4
NOV	494.	478.	849.30	849.58	848.70	399336.	0.	0.	21032600.	29212.	61.02	7[illegible].	0.	.4
DEC	98.	480.	841.93	834.27	841.33	375844.	0.	0.	21618100.	29056.	60.52	7[illegible].	0.	.5
PROJECT NO 1				YEAR OF STUDY 1990										
JAN	59.	453.	826.26	818.25	825.74	351562.	0.	0.	20043300.	26940.	59.34	718.	0.	.5
FEB	80.	468.	809.96	801.67	809.39	330003.	0.	0.	18265400.	27180.	58.05	702.	0.	.5
MAR	110.	464.	793.68	785.70	793.18	309418.	0.	0.	18783000.	25246.	56.76	686.	0.	.5
APR	169.	450.	778.95	772.21	778.44	292654.	0.	0.	18041100.	25057.	55.59	672.	0.	.4
MAY	412.	429.	771.75	771.29	771.26	291557.	0.	0.	17591400.	23644.	55.00	665.	0.	.4
JUN	684.	420.	777.66	784.03	777.18	307250.	0.	0.	16781000.	23307.	55.45	671.	0.	.4
JUL	878.	404.	795.37	806.70	794.89	336384.	0.	0.	17096000.	22978.	56.85	687.	0.	.4
AUG	919.	402.	818.09	829.48	817.62	368168.	0.	0.	17546200.	23583.	58.65	709.	0.	.4
SEP	1077.	423.	841.69	853.91	841.21	407049.	0.	0.	18446000.	25619.	60.48	731.	0.	.4
OCT	532.	430.	855.64	857.37	855.15	413276.	0.	0.	19705200.	26485.	61.49	744.	0.	.4
NOV	492.	473.	857.67	857.97	857.08	414347.	0.	0.	21032600.	29212.	61.62	745.	0.	.5
DEC	209.	474.	853.37	848.78	852.79	398053.	0.	0.	21618100.	29056.	61.30	741.	0.	.5
PROJECT NO 1				YEAR OF STUDY 1991										
JAN	74.	445.	841.33	833.88	840.83	375216.	0.	0.	20043300.	26940.	60.48	731.	0.	.4
FEB	47.	457.	826.36	818.85	825.83	352395.	0.	0.	18265400.	27180.	59.35	718.	0.	.5
MAR	85.	434.	810.63	802.42	810.14	330909.	0.	0.	18783000.	25246.	58.11	703.	0.	.5
APR	127.	440.	795.15	787.88	794.65	312251.	0.	0.	18041100.	25057.	56.87	688.	0.	.4
MAY	543.	418.	790.99	794.09	790.50	319915.	0.	0.	17591400.	23644.	56.51	683.	0.	.4
JUN	859.	404.	804.52	814.95	804.05	346945.	0.	0.	16781000.	23307.	57.58	696.	0.	.4
JUL	1105.	385.	829.68	844.40	829.22	391169.	0.	0.	17096000.	22978.	59.56	720.	0.	.4
AUG	992.	383.	855.14	865.87	854.68	428570.	0.	0.	17546200.	23583.	61.46	743.	0.	.4
SEP	1020.	407.	875.69	885.52	875.22	465044.	0.	0.	18446000.	25619.	62.94	761.	0.	.4
OCT	467.	415.	886.30	887.09	885.82	468191.	0.	0.	19705200.	26485.	63.69	770.	0.	.4
NOV	314.	455.	886.90	882.82	886.42	459655.	0.	0.	21032600.	29212.	63.57	769.	0.	.5
DEC	264.	459.	879.64	876.45	879.10	447614.	0.	0.	21618100.	29056.	63.18	764.	0.	.5
PROJECT NO 1				YEAR OF STUDY 1992										
JAN	95.	430.	870.72	864.99	870.23	426981.	0.	0.	20043300.	26940.	62.56	757.	0.	.4
FEB	76.	440.	859.17	853.35	858.67	406029.	0.	0.	18917700.	27180.	61.73	747.	0.	.4
MAR	59.	415.	846.40	839.46	845.92	384140.	0.	0.	18783000.	25246.	60.83	736.	0.	.4
APR	112.	418.	833.76	828.07	833.28	365912.	0.	0.	18041100.	25057.	[illegible]	[illegible]	0.	.4
MAY	432.	397.	828.73	829.40	828.26	368043.	0.	0.	17591400.	23644.	59.50	720.	0.	.4
JUN	843.	387.	838.19	846.98	837.73	395176.	0.	0.	16781000.	23307.	60.22	728.	0.	.4
JUL	907.	373.	856.26	865.54	855.81	427987.	0.	0.	17096000.	22978.	61.54	744.	0.	.4
AUG	912.	375.	874.52	883.49	874.06	460994.	0.	0.	17546200.	23583.	62.85	760.	0.	.4
SEP	907.	520.	889.24	895.00	888.58	484000.	7116.	5536720.	18446000.	25619.	64.01	774.	0.	.4
OCT	328.	412.	894.20	893.40	893.72	478812.	0.	0.	19705200.	26485.	64.22	777.	0.	.4
NOV	119.	457.	887.86	882.36	887.32	458648.	0.	0.	21032600.	29212.	63.79	771.	0.	.5
DEC	47.	461.	875.36	868.40	874.81	433133.	0.	0.	21618100.	29056.	62.89	761.	0.	.5

	FLOW		POOL ELEVATION		HEAD	STORAG
	NATL	REG	AVERAGE	EOM	AVERAGE	EOM
	CFS	CFS	FTMSL	FTMSL	FT	AF
PROJECT NO 1				YEAR OF STUDY 1993		
JAN	176.	436.	864.00	859.59	863.50	417264.
FEB	129.	442.	854.74	849.90	854.24	399839.
MAR	114.	416.	843.76	837.66	843.30	381261.
APR	207.	416.	833.73	829.80	833.24	366688.
MAY	523.	393.	832.25	834.70	831.78	373273.
JUN	770.	385.	842.17	849.64	841.71	399425.
JUL	1020.	371.	860.73	871.83	860.28	439305.
AUG	838.	373.	879.39	886.94	878.93	467890.
SEP	785.	514.	890.97	895.00	890.32	484000.
OCT	496.	495.	895.00	895.00	894.37	484000.
NOV	344.	454.	893.96	892.92	893.43	477880.
DEC	297.	454.	889.69	886.47	889.17	467749.
PROJECT NO 1				YEAR OF STUDY 1994		
JAN	186.	424.	883.18	879.48	882.69	453079.
FEB	40.	433.	873.42	867.80	872.93	431240.
MAR	99.	407.	862.09	856.82	861.61	412279.
APR	78.	409.	851.07	845.33	850.60	392532.
MAY	329.	389.	844.02	842.71	843.55	388796.
JUN	780.	381.	849.82	856.94	849.36	412699.
JUL	836.	369.	864.90	872.87	864.45	441176.
AUG	790.	373.	879.64	886.40	879.18	466818.
SEP	712.	423.	890.70	895.00	890.21	484000.
OCT	1020.	727.	895.00	895.00	892.97	484000.
NOV	459.	458.	895.00	895.00	894.46	484000.
DEC	136.	454.	890.10	885.21	889.58	466428.
PROJECT NO 1				YEAR OF STUDY 1995		
JAN	19.	426.	878.53	871.86	878.04	439357.
FEB	42.	436.	865.77	859.68	865.27	417626.
MAR	57.	411.	853.47	847.26	852.99	393620.
APR	128.	414.	841.63	835.99	841.15	378597.
MAY	299.	394.	834.18	832.33	833.70	372729.
JUN	672.	387.	837.83	843.34	837.37	389677.
JUL	850.	375.	851.91	860.48	851.45	418865.
AUG	1020.	376.	871.34	882.21	870.89	458429.
SEP	774.	401.	888.08	893.95	887.61	480602.
OCT	518.	482.	894.47	895.00	893.92	484000.
NOV	529.	528.	895.00	895.00	894.33	484000.
DEC	311.	453.	893.04	891.08	892.52	475269.
PROJECT NO 1				YEAR OF STUDY 1996		
JAN	144.	422.	886.57	882.06	886.08	458122.
FEB	255.	430.	879.29	876.53	878.80	447754.
MAR	49.	403.	870.47	864.41	869.99	425951.
APR	117.	405.	859.64	854.86	859.16	408764.
MAY	462.	384.	856.19	857.52	855.73	413563.
JUN	908.	374.	866.34	875.16	865.89	445300.
JUL	902.	361.	884.24	893.31	883.79	478532.
AUG	1029.	727.	894.15	895.00	892.12	484000.
SEP	775.	727.	895.00	895.00	892.97	484000.
OCT	651.	650.	895.00	895.00	893.57	484000.
NOV	171.	456.	890.75	886.50	890.22	467017.
DEC	80.	458.	880.39	874.27	879.85	443693.
PROJECT NO 1				YEAR OF STUDY 1997		
JAN	52.	432.	867.78	861.29	867.29	420326.
FEB	52.	442.	855.22	849.15	854.72	398651.
MAR	57.	417.	841.92	834.69	841.44	375509.
APR	102.	421.	828.60	822.51	828.12	357528.
MAY	337.	401.	821.10	819.69	820.63	353577.
JUN	714.	393.	825.99	832.29	825.53	372674.
JUL	775.	380.	840.18	848.07	839.72	396924.
AUG	828.	383.	855.77	863.47	855.31	424259.
SEP	920.	408.	871.90	880.33	871.43	454676.
OCT	860.	416.	884.07	887.81	883.59	469628.
NOV	115.	440.	882.53	877.25	881.99	449060.
DEC	70.	464.	870.51	863.77	869.96	424801.
PROJECT NO 1				YEAR OF STUDY 1998		
JAN	42.	437.	857.02	850.27	856.52	400486.
FEB	38.	448.	842.84	835.42	842.33	377683.
MAR	39.	424.	827.70	819.98	827.21	353971.
APR	[illegible]	427.	816.83	813.68	816.34	345424.
MAY	509.	403.	816.08	818.49	815.61	351887.
JUN	568.	394.	822.11	825.74	821.65	362187.
JUL	763.	384.	833.04	842.34	832.58	385488.
AUG	788.	386.	847.99	855.63	847.53	410165.
SEP	576.	415.	858.29	860.94	857.81	419704.
OCT	511.	427.	862.37	863.80	861.88	424846.
NOV	425.	470.	863.04	862.28	862.47	422119.
DEC	109.	472.	856.07	849.86	855.49	399774.
PROJECT NO 1				YEAR OF STUDY 1999		
JAN	24.	445.	841.45	833.04	840.95	373867.
FEB	35.	458.	825.21	817.37	824.67	350328.
MAR	48.	435.	808.14	798.91	807.65	324676.
APR	90.	443.	790.74	782.65	790.28	305456.
MAY	287.	425.	779.22	775.79	778.73	296958.
JUN	805.	415.	785.02	794.25	784.54	314108.
JUL	833.	399.	804.54	814.82	804.0[illegible]	34679[illegible]
AUG	1173.	395.	830.72	846.62	830.[illegible]	394604.
SEP	763.	418.	8[illegible]2.51	858.40	[illegible]	[illegible]
OCT	661.	427.	862.39	866.38	861.[illegible]	429490.
NOV	238.	471.	862.52	858.66	861.95	415599.
DEC	180.	473.	853.56	848.45	852.97	397525.
PROJECT NO 1				YEAR OF STUDY 2000		
JAN	43.	445.	840.39	832.34	839.89	372751.
FEB	70.	459.	824.00	815.66	823.46	347931.
MAR	55.	436.	806.56	797.46	806.07	324451.
APR	87.	444.	789.19	780.91	788.69	301394.
MAY	263.	426.	776.76	772.60	776.27	293129.
JUN	604.	420.	777.08	781.56	776.60	302031.
JUL	1143.	402.	799.20	816.84	798.73	349580.
AUG	888.	397.	826.78	836.72	826.31	379757.
SEP	627.	423.	840.80	844.89	840.32	391846.
OCT	619.	434.	848.33	851.77	847.83	401593.
NOV	174.	480.	845.87	839.97	845.27	384962.
DEC	271.	483.	835.88	831.80	835.28	371881.
PROJECT NO 1				YEAR OF STUDY 2001		
JAN	46.	455.	823.26	814.73	822.73	346681.
FEB	38.	471.	805.44	796.16	804.87	322627.
MAR	57.	449.	786.62	777.09	786.11	298513.
APR	142.	457.	768.89	766.64	768.43	279756.
MAY	478.	435.	764.86	763.03	761.36	282340.
JUN	944.	421.	775.91	788.79	775.43	313433.
AUG	797.	400.	820.76	829.36	820.29	367907.
SEP	1018.	424.	840.60	851.80	840.12	403325.
OCT	1486.	423.	869.58	887.32	869.10	468663.
NOV	715.	456.	891.16	895.00	890.62	484000.
DEC	367.	452.	894.19	893.38	893.67	478748.
PROJECT NO 1				YEAR OF STUDY 2002		
JAN	68.	422.	887.43	881.47	886.94	456953.
FEB	76.	432.	875.57	869.66	875.08	435404.
MAR	63.	406.	863.74	857.92	863.32	414270.
APR	110.	409.	852.86	847.79	852.38	396477.
MAY	312.	388.	846.31	844.83	845.85	391767.
JUN	905.	379.	853.81	862.78	853.35	422003.
JUL	761.	367.	869.50	876.22	869.05	447203.
AUG	875.	370.	884.71	893.21	884.26	478199.
SEP	1011.	727.	894.10	895.00	892.07	484000.
OCT	1237.	727.	895.00	895.00	892.97	484000.
NOV	246.	455.	891.87	888.75	891.34	471513.
DEC	163.	457.	884.21	879.47	883.68	453417.

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

STORAGE EOM AF	SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
1993								
417264.	0.	0.	20043300.	26940.	62.06	750.	0.	.4
399839.	0.	0.	18265400.	27180.	61.30	742.	0.	.4
381261.	0.	0.	18783000.	25246.	60.66	734.	0.	.4
360688.	0.	0.	18041100.	25057.	59.90	724.	0.	.4
376523.	0.	0.	17591400.	23644.	59.77	723.	0.	.4
399425.	0.	0.	16781000.	23307.	60.51	732.	0.	.4
439305.	0.	0.	17096000.	22978.	61.86	748.	0.	.4
467890.	0.	0.	17546200.	23583.	63.20	764.	0.	.4
484000.	6797.	5288570.	18446000.	25619.	64.10	775.	0.	.6
484000.	5169.	4021980.	19705200.	26485.	64.29	778.	0.	.6
477409.	0.	0.	21032600.	29212.	64.23	777.	0.	.5
467743.	0.	0.	21618100.	29056.	63.97	774.	0.	.5
1994								
453079.	0.	0.	20043300.	26940.	63.46	767.	0.	.4
431249.	0.	0.	18265400.	27180.	62.76	759.	0.	.4
412279.	0.	0.	18783000.	25246.	61.94	749.	0.	.4
402532.	0.	0.	18041100.	25057.	61.13	739.	0.	.4
408794.	0.	0.	17591400.	23644.	60.65	733.	0.	.4
432499.	0.	0.	16781000.	23307.	61.07	739.	0.	.4
461174.	0.	0.	17096000.	22978.	62.16	752.	0.	.4
480814.	0.	0.	17546200.	23583.	63.22	765.	0.	.4
484000.	1369.	1065370.	18446000.	25619.	64.03	774.	0.	.4
484000.	19350.	15032800.	19705200.	26485.	64.21	777.	18011.	2.0
484000.	280.	217888.	21032600.	29212.	64.30	778.	0.	.5
464428.	0.	0.	21618100.	29056.	63.95	773.	0.	.5
1995								
430357.	0.	0.	20043300.	26940.	63.12	763.	0.	.4
417426.	0.	0.	18265400.	27180.	62.21	752.	0.	.4
395620.	0.	0.	18783000.	25246.	61.33	742.	0.	.4
370597.	0.	0.	18041100.	25057.	60.51	732.	0.	.4
372729.	0.	0.	17591400.	23644.	59.94	725.	0.	.4
399677.	0.	0.	16781000.	23307.	60.19	728.	0.	.4
410865.	0.	0.	17096000.	22978.	61.22	740.	0.	.4
460429.	0.	0.	17546200.	23583.	62.63	757.	0.	.4
480602.	0.	0.	18446000.	25619.	63.83	772.	0.	.4
484000.	3113.	2422410.	19705200.	26485.	64.27	777.	0.	.5
484000.	4442.	3456130.	21032600.	29212.	64.29	777.	0.	.6
479269.	0.	0.	21618100.	29056.	64.14	776.	0.	.5
1996								
460122.	0.	0.	20043300.	26940.	63.70	770.	0.	.4
447754.	0.	0.	18917700.	27180.	63.17	764.	0.	.4
425951.	0.	0.	18783000.	25246.	62.55	756.	0.	.4
413764.	0.	0.	18041100.	25057.	61.74	747.	0.	.4
413543	0.	0.	17591400.	23644.	61.53	744.	0.	.4
435300.	0.	0.	16781000.	23307.	62.26	753.	0.	.4
476532.	0.	0.	17096000.	22978.	63.56	769.	0.	.4
484000.	22129.	17191800.	17546200.	23583.	64.17	776.	13069.	2.0
484000.	19528.	15171400.	18446000.	25619.	64.21	777.	2851.	2.0
484000.	14672.	11405900.	19705200.	26485.	64.23	777.	0.	1.4
467017.	0.	0.	21032600.	29212.	64.00	774.	0.	.5
443693.	0.	0.	21618100.	29056.	63.25	765.	0.	.5
1997								
420326.	0.	0.	20043300.	26940.	62.35	754.	0.	.4
400651.	0.	0.	18265400.	27180.	61.45	743.	0.	.4
370509.	0.	0.	18783000.	25246.	60.52	732.	0.	.4
357526.	0.	0.	18041100.	25057.	59.51	720.	0.	.4
353577.	0.	0.	17591400.	23644.	58.93	713.	0.	.4
372674.	0.	0.	16781000.	23307.	59.29	717.	0.	.4
406924.	0.	0.	17096000.	22978.	60.37	730.	0.	.4
426259.	0.	0.	17546200.	23583.	61.50	744.	0.	.4
444676.	0.	0.	18446000.	25619.	62.66	758.	0.	.4
460628.	0.	0.	19705200.	26485.	63.54	768.	0.	.4
450060.	0.	0.	21032600.	29212.	63.41	767.	0.	.5
434001.	0.	0.	21618100.	29056.	62.94	756.	0.	.5
1998								
400486.	0.	0.	20043300.	26940.	61.58	745.	0.	.4
371683.	0.	0.	18265400.	27180.	60.59	733.	0.	.5
333971.	0.	0.	18783000.	25246.	59.45	719.	0.	.4
325424.	0.	0.	18041100.	25057.	58.59	708.	0.	.4
331087.	0.	0.	17591400.	23644.	58.54	708.	0.	.4
342187.	0.	0.	16781000.	23307.	59.02	714.	0.	.4
360488.	0.	0.	17096000.	22978.	59.83	723.	0.	.4
380145.	0.	0.	17546200.	23583.	60.94	737.	0.	.4
390704.	0.	0.	18446000.	25619.	61.68	746.	0.	.4
386046.	0.	0.	19705200.	26485.	61.97	749.	0.	.4
372119.	0.	0.	21032600.	29212.	62.04	750.	0.	.5
350776.	0.	0.	21618100.	29056.	61.51	744.	0.	.5
1999								
340067.	0.	0.	20043300.	26940.	60.48	731.	0.	.4
320328.	0.	0.	18265400.	27180.	59.23	716.	0.	.5
300076.	0.	0.	18783000.	25246.	57.91	700.	0.	.4
290056.	0.	0.	18041100.	25057.	56.52	684.	0.	.4
290958.	0.	0.	17591400.	23644.	55.60	672.	0.	.4
300100.	0.	0.	16781000.	23307.	56.03	678.	0.	.4
330792.	0.	0.	17096000.	22978.	57.50	696.	0.	.4
360604.	0.	0.	17546200.	23583.	59.64	721.	0.	.4
380823.	0.	0.	18446000.	25619.	61.26	741.	0.	.4
390490.	0.	0.	19705200.	26485.	61.97	749.	0.	.4
380599.	0.	0.	21032600.	29212.	61.96	749.	0.	.5
360525.	0.	0.	21618100.	29056.	61.30	741.	0.	.5
2000								
330751.	0.	0.	20043300.	26940.	60.41	731.	0.	.4
310031.	0.	0.	18917700.	27180.	59.15	715.	0.	.5
290491.	0.	0.	18783000.	25246.	57.78	699.	0.	.4
270194.	0.	0.	18041100.	25057.	56.40	682.	0.	.4
270129.	0.	0.	17591400.	23644.	55.41	670.	0.	.4
280032.	0.	0.	16781000.	23307.	55.39	670.	0.	.4
300388.	0.	0.	17096000.	22978.	57.14	691.	0.	.4
320757.	0.	0.	17546200.	23583.	59.35	718.	0.	.4
350046.	0.	0.	18446000.	25619.	60.44	731.	0.	.4
360393.	0.	0.	19705200.	26485.	60.96	737.	0.	.4
350062.	0.	0.	21032600.	29212.	60.80	735.	0.	.6
330001.	0.	0.	21618100.	29056.	60.06	726.	0.	.6
2001								
300001.	0.	0.	20043300.	26940.	59.09	715.	0.	.5
280027.	0.	0.	18265400.	27180.	57.69	698.	0.	.5
260013.	0.	0.	18783000.	25246.	56.20	680.	0.	.5
240756.	0.	0.	18041100.	25057.	54.80	663.	0.	.5
240300.	0.	0.	17591400.	23644.	54.23	656.	0.	.4
260433.	0.	0.	16781000.	23307.	55.30	669.	0.	.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
320027.	0.	0.	17546200.	23583.	58.89	712.	0.	.4
350025.	0.	0.	18446000.	25619.	60.40	730.	0.	.4
400043.	0.	0.	19706200.	26485.	62.51	756.	0.	.4
484000.	49.	38130.	21032600.	29212.	64.04	774.	0.	.5
470008.	0.	0.	21618100.	29056.	64.22	777.	0.	.5
2002								
450093.	0.	0.	20043300.	26940.	63.76	771.	0.	.4
430004.	0.	0.	18265400.	27180.	62.9?	761.	0.	.4
410070.	0.	0.	18783000.	25246.	62.07	751.	0.	.4
400077.	0.	0.	18041100.	25057.	61.26	741.	0.	.4
410067.	0.	0.	17591400.	23644.	60.84	736.	0.	.4
430010.	0.	0.	16781000.	23307.	61.36	742.	0.	.4
460001.	0.	0.	17096000.	22978.	62.49	756.	0.	.4
480099.	0.	0.	17546200.	23583.	63.59	769.	0.	.4
484000.	19528.	15171400.	18446000.	25619.	64.17	776.	11064.	2.0
484000.	19350.	15032800.	19705200.	26485.	64.21	777.	31354.	2.0
470015.	0.	0.	21032600.	29212.	64.08	775.	0.	.5
450017.	0.	0.	21618100.	29056.	63.53	768.	0.	.5

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: K.H.
CHECKED: [signature]
PREPARED: [signature]

SNETTISHAM, ALASKA

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

SUPERVISED: W. D. Wade Jr. PE
APPROVED: [signature], LtCol, CE
SUBMITTED: [signature]
RECOMMENDED: [signature]

SCALE NONE
DATE AUGUST 1968
FILE NUMBER Q-4-5-113
SHEET 1 OF 3

2

	FLOW NATL CFS	FLOW REG CFS	ELEVATION AVERAGE FTMSL	ELEVATION EOM FTMSL	HEAD AVERAGE FT	STORAGE EOM AF	SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
PROJECT NO 1				YEAR OF STUDY 2003										
JAN	127.	428.	874.52	869.37	874.03	434867.	0.	0.	20043300.	26940.	62.84	760.	0.	.4
FEB	125.	437.	864.54	859.72	864.05	417499.	0.	0.	18265400.	27180.	62.09	751.	0.	.4
MAR	135.	411.	855.00	850.29	854.52	400522.	0.	0.	18783000.	25246.	61.40	743.	0.	.4
APR	93.	412.	844.04	837.80	843.56	381486.	0.	0.	18041100.	25057.	60.68	734.	0.	.4
MAY	537.	391.	840.85	843.89	840.38	390455.	0.	0.	17591400.	23644.	60.45	731.	0.	.4
JUN	704.	381.	849.62	855.35	849.16	409632.	0.	0.	16781000.	23307.	61.06	738.	0.	.4
JUL	859.	370.	863.35	871.36	862.90	438451.	0.	0.	17096000.	22978.	62.05	750.	0.	.4
AUG	720.	374.	877.11	882.86	876.65	459719.	0.	0.	17546200.	23583.	63.04	762.	0.	.4
SEP	1149.	729.	888.93	895.00	886.88	484000.	19529.	15171400.	18446000.	25619.	63.96	773.	654.	2.0
OCT	720.	719.	895.00	895.00	893.03	484000.	18915.	14695600.	19705200.	26485.	64.22	777.	0.	1.9
NOV	217.	456.	891.44	887.88	890.91	469776.	0.	0.	21032600.	29212.	64.05	775.	0.	.5
DEC	183.	457.	883.63	879.38	883.10	452889.	0.	0.	21618100.	29056.	63.49	768.	0.	.5
PROJECT NO 1				YEAR OF STUDY 2004										
JAN	92.	429.	873.62	867.86	873.13	432160.	0.	0.	20043300.	26940.	62.77	759.	0.	.4
FEB	75.	438	862.05	856.24	861.55	411235.	0.	0.	18917700.	27180.	61.94	749.	0.	.4
MAR	53.	413.	849.57	842.90	849.09	389061.	0.	0.	18783000.	25246.	61.03	738.	0.	.4
APR	102.	416.	836.87	830.83	836.39	370341.	0.	0.	18041100.	25057.	60.14	727.	0.	.4
MAY	338.	396	829.71	828.58	829.24	366735.	0.	0.	17591400.	23644.	59.60	721.	0.	.4
JUN	749.	388.	835.43	842.28	834.96	388194.	0.	0.	16781000.	23307.	60.01	726.	0.	.4
JUL	1001.	374.	853.56	864.84	853.10	426712.	0.	0.	17096000.	22978.	61.34	742.	0.	.4
AUG	1254.	373.	879.44	894.04	878.98	480881.	0.	0.	17546200.	23583.	63.22	764.	0.	.4
SEP	786.	721.	894.52	895.00	892.49	484000.	19528.	15171400.	18446000.	25619.	64.18	776.	368.	2.0
OCT	808.	727.	895.00	895.00	892.97	484000.	19350.	15032800.	19705200.	26485.	64.21	777.	4975.	2.0
NOV	382.	454.	894.33	893.67	893.81	479676.	0.	0.	21032600.	29212.	64.24	777.	0.	.5
DEC	246.	454.	890.05	880.43	889.52	466864.	0.	0.	21618100.	29056.	63.94	773.	0.	.5
PROJECT NO 1				YEAR OF STUDY 2005										
JAN	74.	425.	880.78	875.13	880.29	445241.	0.	0.	20043300.	26940.	63.28	765.	0.	.4
FEB	109.	434.	870.10	865.08	869.61	427152.	0.	0.	18265400.	27180.	62.52	756.	0.	.4
MAR	51.	409.	858.97	852.85	858.49	405139.	0.	0.	18783000.	25246.	61.72	746.	0.	.4
APR	146.	411.	847.98	843.11	847.50	389362.	0.	0.	18041100.	25057.	60.94	737.	0.	.4
MAY	501.	388.	845.38	847.65	844.92	396249.	0.	0.	17591400.	23644.	60.78	735.	0.	.4
JUN	727.	379.	853.52	859.38	853.06	416900.	0.	0.	16781000.	23307.	61.34	742.	0.	.4
JUL	944.	367.	869.23	879.07	868.78	452329.	0.	0.	17096000.	22978.	62.47	755.	0.	.4
AUG	1162.	646.	887.03	895.00	885.64	484000.	17007.	13221600.	17546200.	23583.	63.92	773.	0.	1.3
SEP	946.	727.	895.00	895.00	892.97	484000.	19528.	15171400.	18446000.	25619.	64.21	777.	13026.	2.0
OCT	689.	688.	895.00	895.00	893.30	484000.	17009.	13218700.	19705200.	26485.	64.22	777.	0.	1.6
NOV	209.	456.	891.26	887.52	890.73	469056.	0.	0.	21032600.	29212.	64.04	774.	0.	.5
DEC	108.	458.	881.96	876.39	881.42	447504.	0.	0.	21618100.	29056.	63.37	766.	0.	.5
PROJECT NO 1				YEAR OF STUDY 2006										
JAN	44.	431.	869.78	863.17	869.29	423706.	0.	0.	20043300.	26940.	62.50	756.	0.	.4
FEB	73.	441.	857.49	851.81	856.99	403262.	0.	0.	18265400.	27180.	61.61	745.	0.	.4
MAR	64.	415.	844.85	837.89	844.37	381637.	0.	0.	18783000.	25246.	60.72	734.	0.	.4
APR	195.	418.	833.74	829.59	833.26	368350.	0.	0.	18041100.	25057.	59.90	724.	0.	.4
MAY	424.	396.	830.11	830.64	829.64	370032.	0.	0.	17591400.	23644.	59.61	721.	0.	.4
JUN	807.	386.	838.77	846.90	838.31	395039.	0.	0.	16781000.	23307.	60.26	729.	0.	.4
JUL	854.	373.	856.99	867.08	856.53	430760.	0.	0.	17096000.	22978.	61.59	745.	0.	.4
AUG	640.	376.	871.59	876.09	871.13	446963.	0.	0.	17546200.	23583.	62.64	757.	0.	.4
SEP	471.	406.	877.15	878.22	876.68	450806.	0.	0.	18446000.	25619.	63.03	762.	0.	.4
OCT	624.	418.	881.48	884.73	880.99	463468.	0.	0.	19705200.	26485.	63.35	766.	0.	.4
NOV	416.	459.	884.08	883.43	883.54	460870.	0.	0.	21032600.	29212.	63.55	768.	0.	.5
DEC	203.	459.	879.23	875.04	878.69	445073.	0.	0.	21618100.	29056.	63.17	764.	0.	.5
PROJECT NO 1				YEAR OF STUDY 2007										
JAN	98.	431.	869.34	863.65	868.85	424583.	0.	0.	20043300.	26940.	62.46	755.	0.	.4
FEB	95.	440.	858.32	852.99	857.82	405385.	0.	0.	18265400.	27180.	61.67	746.	0.	.4
MAR	104.	414.	846.95	840.91	846.47	386280.	0.	0.	18783000.	25246.	60.87	736.	0.	.4
APR	120.	417.	835.32	829.73	834.84	368579.	0.	0.	18041100.	25057.	60.01	726.	0.	.4
MAY	408.	396.	829.95	830.17	829.48	369286.	0.	0.	17591400.	23644.	59.63	721.	0.	.4
JUN	887.	386.	839.80	849.42	839.34	399084.	0.	0.	16781000.	23307.	60.34	730.	0.	.4
JUL	1130.	370.	862.42	875.43	861.97	445773.	0.	0.	17096000.	22978.	61.99	750.	0.	.4
AUG	1117.	495.	885.21	895.00	884.59	484000.	7656.	5957080.	17546200.	23583.	63.78	771.	0.	.6
SEP	866.	727.	895.00	895.00	892.97	484000.	19528.	15171400.	18446000.	25619.	64.21	777.	8266.	2.0
OCT	786.	727.	895.00	895.00	892.97	484000.	19350.	15032800.	19705200.	26485.	64.21	777.	3622.	2.0
NOV	161.	456.	890.60	886.20	890.07	466418.	0.	0.	21032600.	29212.	63.99	774.	0.	.5
DEC	107.	459.	880.53	874.86	879.99	444759.	0.	0.	21618100.	29056.	63.26	765.	0.	.5
PROJECT NO 1				YEAR OF STUDY 2008										
JAN	110.	431.	869.38	863.89	868.89	425008.	0.	0.	20043300.	26940.	62.47	755.	0.	.4
FEB	61.	440.	857.82	851.75	857.32	403153.	0.	0.	18917700.	27180.	61.64	745.	0.	.4
MAR	93.	415.	845.35	838.95	844.87	383327.	0.	0.	18783000.	25246.	60.76	735.	0.	.4
APR	219.	417.	835.26	831.57	834.78	371517.	0.	0.	18041100.	25057.	60.01	726.	0.	.4
MAY	425.	395.	832.13	832.70	831.66	373323.	0.	0.	17591400.	23644.	59.76	723.	0.	.4
JUN	751.	386.	839.79	846.89	839.33	395028.	0.	0.	16781000.	23307.	60.34	730.	0.	.4
JUL	1110.	371.	859.67	872.45	859.22	440413.	0.	0.	17096000.	22978.	61.79	747.	0.	.4
AUG	982.	371.	882.79	893.13	882.34	477941.	0.	0.	17546200.	23583.	63.45	767.	0.	.4
SEP	1129.	727.	894.06	895.00	892.03	484000.	19528.	15171400.	18446000.	25619.	64.17	776.	17827.	2.0
OCT	1275.	727.	895.00	895.00	892.97	484000.	19350.	15032800.	19705200.	26485.	64.21	777.	33690.	2.0
NOV	425.	454.	894.73	894.46	894.20	482260.	0.	0.	21032600.	29212.	64.30	778.	0.	.5
DEC	358.	452.	893.27	892.08	892.75	476432.	0.	0.	21618100.	29056.	64.17	776.	0.	.5
PROJECT NO 1				YEAR OF STUDY 2009										
JAN	100.	422.	886.68	881.29	886.20	456583.	0.	0.	20043300.	26940.	63.71	770.	0.	.4
FEB	94.	431.	876.15	871.01	875.66	437827.	0.	0.	18265400.	27180.	62.95	761.	0.	.4
MAR	107.	405.	865.91	860.81	865.43	419459.	0.	0.	18783000.	25246.	62.22	752.	0.	.4
APR	123.	407.	856.10	851.40	855.63	402530.	0.	0.	18041100.	25057.	61.48	744.	0.	.4
MAY	418.	386.	851.94	852.49	851.48	404486.	0.	0.	17591400.	23644.	61.22	740.	0.	.4
JUN	982.	375.	862.51	872.52	862.05	440548.	0.	0.	16781000.	23307.	61.99	750.	0.	.4
JUL	882.	362.	880.88	889.23	880.43	472466.	0.	0.	17096000.	22978.	63.31	766.	0.	.4
AUG	846.	658.	892.11	895.00	890.64	484000.	17846.	13872600.	17546200.	23583.	64.13	776.	0.	1.4
SEP	658.	657.	895.00	895.00	893.52	484000.	15418.	11985300.	18446000.	25619.	64.23	777.	0.	1.4
OCT	1018.	727.	895.00	895.00	892.97	484000.	19350.	15032800.	19705200.	26485.	64.21	777.	17888.	2.0
NOV	382.	454.	894.33	893.67	893.81	479676.	0.	0.	21032600.	29212.	64.24	777.	0.	.5
DEC	277.	454.	890.53	887.39	890.00	468790.	0.	0.	21618100.	29056.	63.99	774.	0.	.5
PROJECT NO 1				YEAR OF STUDY 2010										
JAN	53.	425.	881.44	875.49	880.93	445896.	0.	0.	20043300.	26940.	63.33	766.	0.	.4
FEB	42.	435.	869.43	863.37	868.93	424067.	0.	0.	18265400.	27180.	62.47	755.	0.	.4
MAR	68.	409.	857.06	851.69	857.06	403057.	0.	0.	18783000.	25246.	61.62	745.	0.	.4
APR	114.	412.	845.96	840.23	845.48	385324.	0.	0.	18041100.	25057.	60.81	735.	0.	.4
MAY	507.	390.	842.27	845.11	842.10	392501.	0.	0.	17591400.	23644.	60.58	733.	0.	.4
JUN	784.	380.	852.32	859.33	851.86	416809.	0.	0.	16781000.	23307.	61.25	741.	0.	.4
JUL	973.	367.	869.67	880.01	869.22	454033.	0.	0.	17096000.	22978.	62.51	756.	0.	.4
AUG	768.	370.	886.66	893.30	886.21	478501.	0.	0.	17546200.	23583.	63.73	771.	0.	.6
SEP	930.	727.	894.15	895.00	892.12	484000.	19528.	15171400.	18446000.	25619.	64.17	776.	6547.	2.0
OCT	1284.	727.	895.00	895.00	892.97	484000.	19350.	15032800.	19705200.	26485.	64.21	777.	34244.	2.0
NOV	144.	456.	890.34	885.69	889.81	465398.	0.	0.	21032600.	29212.	63.97	774.	0.	.5
DEC	64.	459.	879.32	872.94	878.75	441302.	0.	0.	21618100.	29056.	63.18	764.	0.	.5
PROJECT NO 1				YEAR OF STUDY 2011										
JAN	39.	432.	866.22	859.49	865.72	417088.	0.	0.	20043300.	26940.	62.24	753.	0.	.4
FEB	44.	443.	853.15	846.81	852.53	394909.	0.	0.	18265400.	27180.	61.30	741.	0.	.4
MAR	53.	416.	839.48	832.15	839.00	372446.	0.	0.	18783000.	25246.	60.34	730.	0.	.4
APR	86.	422.	825.51	818.87	825.02	352418.	0.	0.	18041100.	25057.	59.29	717.	0.	.4
MAY	592.	400.	822.93	827.00	822.46	364213.	0.	0.	17591400.	23644.	59.08	714.	0.	.4
JUN	872.	387.	836.32	845.63	835.85	393017.	0.	0.	16781000.	23307.	60.08	726.	0.	.4
JUL	805.	374.	853.22	860.81	852.77	419474.	0.	0.	17096000.	22978.	61.32	742.	0.	.4
AUG	963.	376.	870.78	880.75	870.33	455514.	0.	0.	17546200.	23583.	62.59	757.	0.	.4
SEP	710.	402.	885.35	889.90	884.85	473809.	0.	0.	18446000.	25619.	63.63	769.	0.	.4
OCT	589.	423.	892.45	895.00	891.96	484000.	636.	494945.	19705200.	26485.	64.14	776.	0.	.4
NOV	357.	454.	894.10	893.21	893.58	478187.	0.	0.	21032600.	29212.	64.24	777.	0.	.5
DEC	89.	455.	887.01	880.81	886.48	455624.	0.	0.	21618100.	29056.	63.75	771.	0.	.5
PROJECT NO 1				YEAR OF STUDY 2012										
JAN	61.	426.	874.58	868.34	874.09	433022.	0.	0.	20043300.	26940.	62.84	760.	0.	.4
FEB	56.	438.	862.23	856.11	861.73	411009.	0.	0.	18917700.	27180.	61.95	749.	0.	.4
MAR	159.	412.	851.62	847.13	851.14	395414.	0.	0.	18783000.	25246.	61.16	740.	0.	.4
APR	177.	413.	842.41	837.69	841.93	381318.	0.	0.	18041100.	25057.	60.53	732.	0.	.4
MAY	512.	391.	840.18	842.66	839.71	388732.	0.	0.	17591400.	23644.	60.40	730.	0.	.4
JUN	864.	380.	851.18	859.70	850.72	417472.	0.	0.	16781000.	23307.	61.17	740.	0.	.4
JUL	805.	368.	867.15	874.61	866.70	444300.	0.	0.	17096000.	22978.	62.32	754.	0.	.4
AUG	715.	372.	880.14	885.67	879.68	465341.	0.	0.	17546200.	23583.	63.26	765.	0.	.4
SEP	1133.	729.	890.33	895.00	888.29	484000.	19529.	15171400.	18446000.	25619.	64.03	774.	5374.	2.0
OCT	489.	488.	895.00	895.00	894.38	484000.	4739.	3687430.	19705200.	26485.	64.29	778.	0.	.6
NOV	340.	454.	893.85	892.71	893.18	477168.	0.	0.	21032600.	29212.	64.22	777.	0.	.5
DEC	125.	455.	887.06	881.41	886.53	456825.	0.	0.	21618100.	29056.	63.74	771.	0.	.5

	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT
PROJECT NO 1			YEAR OF STUDY		
JAN	107.	427.	876.00	870.60	875.51
FEB	44.	437.	864.76	858.93	864.27
MAR	50.	412.	852.53	846.13	852.05
APR	64.	415.	839.28	832.44	838.80
MAY	570.	393.	835.82	839.21	835.36
JUN	969.	381.	849.46	859.72	849.00
JUL	905.	367.	868.89	878.06	868.44
AUG	799.	370.	885.25	892.44	884.80
SEP	1141.	727.	893.72	895.00	891.69
OCT	653.	652.	895.00	895.00	893.56
NOV	257.	455.	892.04	889.08	891.51
DEC	209.	456.	885.27	881.46	884.73
PROJECT NO 1			YEAR OF STUDY		
JAN	88.	428.	875.73	870.00	875.24
FEB	44.	437.	865.95	857.85	865.43
MAR	36.	412.	851.49	845.12	851.01
APR	120.	415.	839.32	833.52	838.84
MAY	503.	393.	835.61	837.71	835.15
JUN	705.	384.	843.97	850.23	843.51
JUL	817.	372.	857.82	865.41	857.37
AUG	894.	375.	874.11	882.81	873.66
SEP	839.	429.	888.90	895.00	888.41
OCT	521.	520.	895.00	895.00	894.34
NOV	872.	727.	895.00	895.00	892.97
DEC	124.	454.	889.92	884.84	889.39
PROJECT NO 1			YEAR OF STUDY		
JAN	51.	426.	878.35	871.65	877.86
FEB	28.	437.	865.54	859.23	865.05
MAR	39.	412.	852.64	846.05	852.16
APR	66.	415.	839.25	832.44	838.77
MAY	332.	395.	831.21	829.49	830.74
JUN	727.	387.	836.47	842.97	836.01
JUL	859.	375.	851.73	860.49	851.28
AUG	734.	378.	866.56	872.63	866.11
SEP	909.	404.	880.50	888.37	880.03
OCT	282.	415.	886.31	884.25	885.83
NOV	102.	462.	878.52	872.60	877.97
DEC	50.	467.	865.67	858.55	865.11
PROJECT NO 1			YEAR OF STUDY		
JAN	49.	440.	851.54	844.52	851.04
FEB	43.	451.	836.89	829.26	836.37
MAR	52.	428.	821.16	813.06	820.67
APR	101.	434.	805.40	797.74	804.91
MAY	412.	414.	797.70	797.65	797.22
JUN	868.	402.	808.29	818.86	807.78
JUL	954.	385.	830.27	841.69	829.85
AUG	637.	387.	846.59	851.50	846.13
SEP	699.	416.	856.17	860.84	855.69
OCT	293.	429.	858.51	856.18	858.02
NOV	122.	478.	849.85	843.52	849.25
DEC	86.	483.	835.65	827.78	835.04
PROJECT NO 1			YEAR OF STUDY		
JAN	36.	458.	818.34	808.90	817.80
FEB	36.	475.	799.48	790.07	798.90
MAR	47.	453.	780.07	770.08	779.55
APR	142.	461.	761.73	753.30	761.18
MAY	415.	442.	752.64	751.99	752.18
JUN	692.	432.	758.65	765.32	758.16
JUL	965.	415.	779.75	794.17	779.27
AUG	905.	408.	805.64	817.51	805.36
SEP	1042.	430.	829.44	841.37	828.95
OCT	1062.	432.	852.81	864.25	852.32
NOV	420.	470.	863.41	862.57	862.83
DEC	114.	472.	856.45	850.34	855.87
PROJECT NO 1			YEAR OF STUDY		
JAN	55.	444.	842.56	834.78	842.06
FEB	63.	457.	827.66	820.54	827.12
MAR	46.	433.	811.47	802.41	810.98
APR	80.	441.	794.05	785.60	793.55
MAY	540.	419.	788.60	791.50	788.11
JUN	891.	405.	802.70	813.89	802.22
JUL	877.	388.	824.05	834.20	823.58
AUG	961.	388.	845.13	856.07	844.67
SEP	832.	413.	863.00	869.92	862.52
OCT	858.	420.	877.16	884.39	876.67
NOV	135.	462.	879.22	874.08	878.67
DEC	131.	465.	868.34	862.62	867.76
PROJECT NO 1			YEAR OF STUDY		
JAN	67.	437.	856.29	849.95	855.79
FEB	260.	446.	846.60	843.26	846.10
MAR	56.	420.	836.06	828.85	835.57
APR	47.	425.	820.95	813.05	820.46
MAY	303.	407.	810.55	808.05	810.08
JUN	712.	398.	815.06	822.07	814.59
JUL	771.	385.	829.65	837.26	829.19
AUG	596.	389.	841.51	845.79	841.05
SEP	858.	417.	853.30	860.81	852.81
OCT	440.	420.	861.01	861.22	860.52
NOV	444.	472.	860.75	860.29	860.17
DEC	346.	471.	858.15	856.01	857.58
PROJECT NO 1			YEAR OF STUDY		
JAN	84.	441.	849.38	842.75	848.88
FEB	52.	452.	835.37	828.00	834.85
MAR	57.	429.	819.80	811.60	819.31
APR	63.	435.	803.19	794.79	802.70
MAY	270.	418.	791.10	787.41	790.61
JUN	633.	411.	792.57	797.72	792.09
JUL	978.	395.	811.23	824.74	810.76
AUG	1081.	391.	838.21	851.68	837.74
SEP	798.	415.	858.00	864.32	857.52
OCT	319.	427.	862.47	860.63	861.98
NOV	200.	475.	856.08	851.53	855.49
DEC	52.	479.	843.10	834.47	842.50
PROJECT NO 1			YEAR OF STUDY		
JAN	28.	454.	826.00	817.33	825.47
FEB	28.	469.	807.86	798.39	807.29
MAR	38.	447.	788.58	778.78	788.08
APR	66.	446.	769.69	759.83	769.12
MAY	467.	437.	759.17	759.79	758.67
JUN	558.	429.	763.26	766.74	762.77
JUL	964.	412.	780.58	794.42	780.10
AUG	1278.	404.	813.78	833.13	813.30
SEP	631.	426.	837.00	840.87	836.51
OCT	353.	439.	839.16	837.45	838.66
NOV	410.	486.	836.03	834.61	835.42
DEC	328.	486.	831.57	828.52	830.96
PROJECT NO 1			YEAR OF STUDY		
JAN	115.	457.	821.18	813.84	820.64
FEB	42.	471.	804.68	795.53	804.11
MAR	33.	449.	785.31	775.09	784.79
APR	82.	449.	765.11	755.53	764.77
MAY	446.	439.	755.69	755.85	755.20
JUN	756.	428.	764.38	772.92	763.89
JUL	784.	411.	782.04	791.16	781.56
AUG	762.	412.	799.47	807.78	798.99
SEP	967.	436.	819.03	830.29	818.54
OCT	354.	443.	832.43	834.56	831.93
NOV	424.	488.	833.37	832.18	832.75
DEC	112.	491.	824.37	816.56	823.75

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

STORAGE EOM AF	SECONDARY ENERGY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
2013								
37090.	0.	0.	20043300.	26940.	62.94	761.	0.	.4
16075.	0.	0.	18265400.	27180.	62.13	751.	0.	.4
03811.	0.	0.	18783000.	25246.	61.26	741.	0.	.4
72908.	0.	0.	18041100.	25057.	60.33	730.	0.	.4
83744.	0.	0.	17591400.	23644.	60.04	726.	0.	.4
17406.	0.	0.	16781000.	23307.	61.04	738.	0.	.4
50518.	0.	0.	17096000.	22978.	62.45	755.	0.	.4
76855.	0.	0.	17546200.	23583.	63.62	769.	0.	.4
84000.	19528.	15171400.	18446000.	25619.	64.16	776.	17447.	2.0
84000.	14795.	11501400.	19705200.	26485.	64.23	777.	0.	1.4
72162.	0.	0.	21032600.	29212.	64.06	775.	0.	.5
56926.	0.	0.	21618100.	29056.	63.61	769.	0.	.5
2014								
56014.	0.	0.	20043300.	26940.	62.92	761.	0.	.4
24142.	0.	0.	18265400.	27180.	62.07	751.	0.	.4
32203.	0.	0.	18783000.	25246.	61.15	739.	0.	.4
74635.	0.	0.	18041100.	25057.	60.34	730.	0.	.4
81565.	0.	0.	17591400.	23644.	60.03	726.	0.	.4
30428.	0.	0.	16781000.	23307.	60.64	733.	0.	.4
27747.	0.	0.	17096000.	22978.	61.65	746.	0.	.4
79636.	0.	0.	17546200.	23583.	62.82	760.	0.	.4
84000.	1702.	1324510.	18446000.	25619.	63.92	773.	0.	.4
84000.	6706.	5217680.	19705200.	26485.	64.29	777.	0.	.6
84000.	16199.	12584800.	21032600.	29212.	64.21	777.	8624.	2.0
53684.	0.	0.	21618100.	29056.	63.94	773.	0.	.5
2015								
39345.	0.	0.	20043300.	26940.	63.11	763.	0.	.4
24630.	0.	0.	18265400.	27180.	62.19	752.	0.	.4
03693.	0.	0.	18783000.	25246.	61.27	741.	0.	.4
72908.	0.	0.	18041100.	25057.	60.35	730.	0.	.4
56979.	0.	0.	17591400.	23644.	59.72	722.	0.	.4
39160.	0.	0.	16781000.	23307.	60.09	727.	0.	.4
18006.	0.	0.	17096000.	22978.	61.21	740.	0.	.4
50745.	0.	0.	17546200.	23583.	62.28	753.	0.	.4
70747.	0.	0.	18446000.	25619.	63.28	765.	0.	.4
67512.	0.	0.	19705200.	26485.	63.67	770.	0.	.4
61045.	0.	0.	21032600.	29212.	63.12	763.	0.	.5
35396.	0.	0.	21618100.	29056.	62.20	752.	0.	.5
2016								
31339.	0.	0.	20043300.	26940.	61.19	740.	0.	.4
17819.	0.	0.	18917700.	27180.	60.14	727.	0.	.5
24681.	0.	0.	18783000.	25246.	58.94	713.	0.	.4
20847.	0.	0.	18041100.	25057.	57.69	698.	0.	.4
40718.	0.	0.	17591400.	23644.	57.09	690.	0.	.4
62408.	0.	0.	16781000.	23307.	57.88	700.	0.	.4
17367.	0.	0.	17096000.	22978.	59.61	721.	0.	.4
32699.	0.	0.	17546200.	23583.	60.83	736.	0.	.4
49517.	0.	0.	18446000.	25619.	61.53	744.	0.	.4
41137.	0.	0.	19705200.	26485.	61.69	746.	0.	.4
39027.	0.	0.	21032600.	29212.	61.09	738.	0.	.5
25462.	0.	0.	21618100.	29056.	60.04	726.	0.	.6
2017								
0667.	0.	0.	20043300.	26940.	58.72	710.	0.	.5
5085.	0.	0.	18265400.	27180.	57.21	692.	0.	.5
3100.	0.	0.	18783000.	25246.	55.68	673.	0.	.5
1060.	0.	0.	18041100.	25057.	54.23	656.	0.	.5
9390.	0.	0.	17591400.	23644.	53.47	647.	0.	.4
6057.	0.	0.	16781000.	23307.	53.94	652.	0.	.4
3010.	0.	0.	17096000.	22978.	55.60	672.	0.	.4
3519.	0.	0.	17546200.	23583.	57.68	698.	0.	.4
0923.	0.	0.	18446000.	25619.	59.55	720.	0.	.4
3651.	0.	0.	19705200.	26485.	61.28	741.	0.	.4
1638.	0.	0.	21032600.	29212.	62.06	751.	0.	.5
4615.	0.	0.	21618100.	29056.	61.53	744.	0.	.5
2018								
9648.	0.	0.	20043300.	26940.	60.56	732.	0.	.4
5755.	0.	0.	18265400.	27180.	59.44	719.	0.	.5
9902.	0.	0.	18783000.	25246.	58.17	703.	0.	.4
9908.	0.	0.	18041100.	25057.	56.79	687.	0.	.4
9805.	0.	0.	17591400.	23644.	56.33	681.	0.	.4
9677.	0.	0.	16781000.	23307.	57.43	694.	0.	.4
1722.	0.	0.	17096000.	22978.	59.16	715.	0.	.4
9935.	0.	0.	17546200.	23583.	60.73	734.	0.	.4
8084.	0.	0.	18446000.	25619.	62.02	750.	0.	.4
1789.	0.	0.	19705200.	26485.	63.04	762.	0.	.4
9800.	0.	0.	21032600.	29212.	63.17	764.	0.	.5
1729.	0.	0.	21618100.	29056.	62.39	754.	0.	.5
019								
820.	0.	0.	20043300.	26940.	61.53	744.	0.	.4
567.	0.	0.	18265400.	27180.	60.86	736.	0.	.5
173.	0.	0.	18783000.	25246.	60.07	726.	0.	.4
560.	0.	0.	18041100.	25057.	58.92	713.	0.	.4
273.	0.	0.	17591400.	23644.	58.09	702.	0.	.4
900.	0.	0.	16781000.	23307.	58.41	706.	0.	.4
308.	0.	0.	17096000.	22978.	59.57	720.	0.	.4
266.	0.	0.	17546200.	23583.	60.50	732.	0.	.4
562.	0.	0.	18446000.	25619.	61.32	742.	0.	.4
197.	0.	0.	19705200.	26485.	61.87	748.	0.	.4
320.	0.	0.	21032600.	29212.	61.88	748.	0.	.5
793.	0.	0.	21618100.	29056.	61.67	746.	0.	.5
20								
54.	0.	0.	20043300.	26940.	61.02	738.	0.	.4
799.	0.	0.	18917700.	27180.	60.02	726.	0.	.5
322.	0.	0.	18783000.	25246.	58.83	711.	0.	.4
749.	0.	0.	18041100.	25057.	57.51	69[illegible]	0.	.4
461.	0.	0.	17591400.	23644.	56.54	6[illegible]	0.	.4
315.	0.	0.	16781000.	23307.	56.62	6[illegible]	0.	.4
330.	0.	0.	17096000.	22978.	58.11	70[illegible]	0.	.4
320.	0.	0.	17546200.	23583.	60.22	728	0.	.4
790.	0.	0.	18446000.	25619.	61.66	746	0.	.4
33.	0.	0.	19705200.	26485.	61.98	750.	0.	.4
65.	0.	0.	21032600.	29212.	61.48	744.	0.	.5
00.	0.	0.	21618100.	29056.	60.59	733.	0.	.5
21								
67.	0.	0.	20043300.	26940.	59.29	717.	0.	.5
65.	0.	0.	18265400.	27180.	57.88	700.	0.	.5
99.	0.	0.	18783000.	25246.	56.36	681.	0.	.5
34.	0.	0.	18041100.	25057.	54.78	662.	0.	.5
84.	0.	0.	17591400.	23644.	54.03	653.	0.	.4
14.	0.	0.	16781000.	23307.	54.29	656.	0.	.4
97.	0.	0.	17096000.	22978.	55.66	673.	0.	.4
22.	0.	0.	17546200.	23583.	58.31	705.	0.	.4
17.	0.	0.	18446000.	25619.	60.13	727.	0.	.4
20.	0.	0.	19705200.	26485.	60.32	729.	0.	.4
59.	0.	0.	21032600.	29212.	60.05	726.	0.	.6
52.	0.	0.	21618100.	29056.	59.74	722.	0.	.6
22								
10.	0.	0.	20043300.	26940.	58.94	713.	0.	.5
80.	0.	0.	18265400.	27180.	57.63	697.	0.	.5
11.	0.	0.	18783000.	25246.	56.10	678.	0.	.5
19.	0.	0.	18041100.	25057.	54.52	659.	0.	.5
22.	0.	0.	17591400.	23644.	53.75	650.	0.	.4
12.	0.	0.	16781000.	23307.	54.39	658.	0.	.4
90.	0.	0.	17096000.	22978.	55.79	675.	0.	.4
32.	0.	0.	17546200.	23583.	57.10	691.	0.	.4
77.	0.	0.	18446000.	25619.	58.73	710.	0.	.4
38.	0.	0.	19705200.	26485.	59.78	723.	0.	.4
50.	0.	0.	21032600.	29212.	59.85	724.	0.	.6
59.	0.	0.	21618100.	29056.	59.17	716.	0.	.6

REVISION | DATE | DESCRIPTION | BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: K.H.
CHECKED: [illegible]
PREPARED: [illegible]

SNETTISHAM, ALASKA

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

SUPERVISED: M.B. Wade Jr. PE
APPROVED: [illegible], Lt Col, CE
SUBMITTED: [illegible]
RECOMMENDED: [illegible]

SCALE NONE | DATE AUGUST 1968

FILE NUMBER Q-4-5-113

SHEET 2 OF 3

CORPS OF ENGINEERS

	FLOW		ELEVATION		HEAD	STORAGE	SECONDARY		PRIMARY			
	NATL CFS	REG CFS	AVERAGE FTMSL	EOM FTMSL	AVERAGE FT	EOM AF	SPILL AF	ENERGY KWH	ENERGY KWH	POWER KW	KW/CFS	KWH/AF
PROJECT NO 1				YEAR OF STUDY 2023								
JAN	182.	464.	809.87	803.19	809.37	331816.	0.	0.	20043300.	26940.	58.04	702.
FEB	66.	478.	794.26	785.12	793.44	308927.	0.	0.	18265400.	27180.	56.80	687.
MAR	47.	456.	774.81	764.30	774.28	283774.	0.	0.	18783000.	25246.	55.27	668.
APR	142.	465.	756.09	747.88	755.53	264458.	0.	0.	18041100.	25057.	53.73	650.
MAY	518.	444.	749.77	751.66	749.27	268999.	0.	0.	17591400.	23644.	53.23	644.
JUN	985.	427.	765.89	780.12	765.40	302166.	0.	0.	16781000.	23307.	54.50	659.
JUL	925.	405.	792.59	805.06	792.12	334090.	0.	0.	17096000.	22978.	56.62	685.
AUG	934.	402.	816.83	828.59	816.35	366793.	0.	0.	17546200.	23583.	58.54	708.
SEP	501.	429.	829.91	831.23	829.42	370902.	0.	0.	18446000.	25619.	59.59	721.
OCT	706.	440.	836.43	841.63	835.93	387209.	0.	0.	19705200.	26485.	60.08	727.
NOV	240.	465.	836.96	832.29	836.35	372673.	0.	0.	21032600.	29212.	60.15	727.
DEC	135.	490.	825.00	817.71	824.39	350000.	0.	0.	21618100.	29056.	59.22	716.
PROJECT NO 1				YEAR OF STUDY 2024								
JAN	66.	465.	808.24	798.76	807.68	326265.	0.	0.	20043300.	26940.	57.91	700.
FEB	60.	481.	789.51	780.27	788.91	302356.	0.	0.	18917700.	27180.	56.42	682.
MAR	57.	460.	769.53	758.80	768.99	277563.	0.	0.	18783000.	25246.	54.86	663.
APR	94.	470.	749.46	740.12	748.88	255167.	0.	0.	18041100.	25057.	53.23	644.
MAY	403.	451.	738.07	737.62	738.35	252147.	0.	0.	17591400.	23644.	52.33	633.
JUN	855.	439.	747.92	758.23	747.43	276880.	0.	0.	16781000.	23307.	53.06	641.
JUL	1143.	416.	776.85	795.47	776.37	321657.	0.	0.	17096000.	22978.	55.39	670.
AUG	845.	401.	805.76	816.05	805.28	348675.	0.	0.	17546200.	23583.	57.68	697.
SEP	551.	420.	818.49	820.93	817.99	355309.	0.	0.	18446000.	25619.	58.74	710.
OCT	535.	446.	822.83	824.74	822.32	360640.	0.	0.	19705200.	26485.	59.08	714.
NOV	259.	496.	819.66	814.58	819.03	346497.	0.	0.	21032600.	29212.	58.81	711.
DEC	190.	502.	807.03	799.48	806.39	327277.	0.	0.	21618100.	29056.	57.81	699.
PROJECT NO 1				YEAR OF STUDY 2025								
JAN	86.	476.	790.21	780.95	789.62	303238.	0.	0.	20043300.	26940.	56.40	683.
FEB	52.	494.	770.32	759.69	769.70	278638.	0.	0.	18265400.	27180.	54.91	664.
MAR	68.	474.	749.28	738.67	748.70	253651.	0.	0.	18783000.	25246.	53.21	643.
APR	139.	485.	729.90	720.93	729.29	233022.	0.	0.	18041100.	25057.	51.59	624.
MAY	446.	463.	720.37	719.81	719.81	231800.	0.	0.	17591400.	23644.	50.75	614.
JUN	666.	455.	725.46	731.10	724.95	244322.	0.	0.	16781000.	23307.	51.16	619.
JUL	986.	435.	745.21	759.33	744.72	278197.	0.	0.	17096000.	22978.	52.81	639.
AUG	919.	428.	772.10	784.87	771.61	308337.	0.	0.	17546200.	23583.	54.99	665.
SEP	925.	450.	795.85	806.84	795.34	336581.	0.	0.	18446000.	25619.	56.88	688.
OCT	773.	453.	814.20	821.57	813.68	356197.	0.	0.	19705200.	26485.	58.34	705.
NOV	317.	498.	817.62	813.68	817.00	345423.	0.	0.	21032600.	29212.	58.64	709.
DEC	276.	501.	808.31	802.95	807.68	331943.	0.	0.	21618100.	29056.	57.91	700.
PROJECT NO 1				YEAR OF STUDY 2026								
JAN	123.	474.	794.53	786.12	793.95	309956.	0.	0.	20043300.	26940.	56.82	687.
FEB	119.	489.	777.77	769.42	777.15	289364.	0.	0.	18265400.	27180.	55.49	671.
MAR	94.	466.	759.47	749.52	758.90	266430.	0.	0.	18783000.	25246.	54.06	654.
APR	191.	475.	742.46	735.39	741.87	249475.	0.	0.	18041100.	25057.	52.64	637.
MAY	470.	453.	736.04	736.69	735.51	251031.	0.	0.	17591400.	23644.	52.11	630.
JUN	960.	438.	749.74	762.80	749.25	282080.	0.	0.	16781000.	23307.	53.18	643.
JUL	1282.	410.	784.50	806.20	784.02	335679.	0.	0.	17096000.	22978.	56.00	677.
AUG	1400.	397.	827.26	848.33	826.79	397341.	0.	0.	17546200.	23583.	59.37	718.
SEP	679.	418.	852.74	857.15	852.25	412869.	0.	0.	18446000.	25619.	61.28	741.
OCT	906.	425.	865.35	873.55	864.86	442392.	0.	0.	19705200.	26485.	62.19	752.
NOV	194.	467.	869.02	864.49	868.45	426089.	0.	0.	21032600.	29212.	62.42	755.
DEC	53.	471.	857.34	850.19	856.76	400345.	0.	0.	21618100.	29056.	61.60	745.
PROJECT NO 1				YEAR OF STUDY 2027								
JAN	173.	443.	844.69	839.19	844.19	383708.	0.	0.	20043300.	26940.	60.73	734.
FEB	74.	454.	832.58	825.98	832.06	362576.	0.	0.	18265400.	27180.	59.80	723.
MAR	87.	430.	818.19	810.40	817.70	341486.	0.	0.	18783000.	25246.	58.71	710.
APR	80.	436.	802.40	794.41	801.91	320295.	0.	0.	18041100.	25057.	57.45	695.
MAY	288.	418.	791.16	787.92	790.68	312296.	0.	0.	17591400.	23644.	56.55	684.
JUN	753.	409.	795.93	803.94	795.45	332730.	0.	0.	16781000.	23307.	56.90	688.
JUL	851.	393.	814.41	824.89	813.95	360853.	0.	0.	17096000.	22978.	58.37	706.
AUG	787.	394.	832.44	839.99	831.97	384989.	0.	0.	17546200.	23583.	59.78	723.
SEP	1042.	418.	851.12	862.26	850.64	422069.	0.	0.	18446000.	25619.	61.16	740.
OCT	559.	426.	864.52	866.79	864.03	430228.	0.	0.	19705200.	26485.	62.13	751.
NOV	383.	469.	865.36	863.93	864.79	425073.	0.	0.	21032600.	29212.	62.19	752.
DEC	284.	469.	860.75	857.58	860.18	413647.	0.	0.	21618100.	29056.	61.84	748.
PROJECT NO 1				YEAR OF STUDY 2028								
JAN	137.	440.	852.23	846.88	851.73	395012.	0.	0.	20043300.	26940.	61.21	740.
FEB	203.	449.	842.14	837.41	841.63	380855.	0.	0.	18917700.	27180.	60.51	732.
MAR	103.	422.	831.26	825.11	830.77	361188.	0.	0.	18783000.	25246.	59.70	722.
APR	109.	426.	818.09	811.06	817.60	342275.	0.	0.	18041100.	25057.	58.70	710.
MAY	366.	407.	810.08	809.09	809.60	339736.	0.	0.	17591400.	23644.	58.05	702.
JUN	699.	398.	815.83	822.58	815.36	357613.	0.	0.	16781000.	23307.	58.47	707.
JUL	892.	384.	832.65	842.73	832.19	388833.	0.	0.	17096000.	22978.	59.80	723.
AUG	715.	386.	848.87	855.01	848.41	409026.	0.	0.	17546200.	23583.	61.00	738.
SEP	1168.	410.	867.52	880.03	867.04	454078.	0.	0.	18446000.	25619.	62.35	754.
OCT	927.	417.	881.71	883.39	881.23	460782.	0.	0.	19705200.	26485.	63.36	766.
NOV	128.	463.	878.04	872.69	877.49	440867.	0.	0.	21032600.	29212.	63.09	763.
DEC	93.	466.	866.30	859.92	865.74	417864.	0.	0.	21618100.	29056.	62.24	753.
PROJECT NO 1				YEAR OF STUDY 2029								
JAN	47.	439.	853.00	846.08	852.50	393730.	0.	0.	20043300.	26940.	61.29	741.
FEB	46.	450.	838.74	831.40	838.22	371248.	0.	0.	18265400.	27180.	60.29	729.
MAR	47.	427.	823.51	815.62	823.02	347880.	0.	0.	18783000.	25246.	59.11	715.
APR	122.	432.	808.39	801.16	807.90	329402.	0.	0.	18041100.	25057.	57.93	700.
MAY	239.	414.	797.08	793.00	796.60	318602.	0.	0.	17591400.	23644.	57.02	689.
JUN	816.	405.	802.33	811.66	801.86	343001.	0.	0.	16781000.	23307.	57.41	694.
JUL	807.	390.	820.71	829.76	820.25	368628.	0.	0.	17096000.	22978.	58.88	712.
AUG	1011.	389.	841.77	853.78	841.31	406820.	0.	0.	17546200.	23583.	60.49	731.
SEP	982.	412.	863.19	872.60	862.71	440681.	0.	0.	18446000.	25619.	62.04	750.
OCT	605.	420.	875.74	878.89	875.26	452005.	0.	0.	19705200.	26485.	62.93	761.
NOV	137.	465.	873.46	868.03	872.90	432462.	0.	0.	21032600.	29212.	62.76	759.
DEC	82.	469.	861.41	854.80	860.84	408639.	0.	0.	21618100.	29056.	61.89	748.
PROJECT NO 1				YEAR OF STUDY 2030								
JAN	83.	442.	847.95	841.11	847.45	386598.	0.	0.	20043300.	26940.	60.93	737.
FEB	123.	452.	835.31	829.52	834.79	368238.	0.	0.	18265400.	27180.	60.01	726.
MAR	49.	428.	821.39	813.27	820.90	344923.	0.	0.	18783000.	25246.	58.95	713.
APR	63.	434.	804.78	796.29	804.28	322806.	0.	0.	18041100.	25057.	57.64	697.
MAY	316.	416.	793.82	791.35	793.34	316623.	0.	0.	17591400.	23644.	56.76	686.
JUN	656.	409.	797.05	802.76	796.58	331317.	0.	0.	16781000.	23307.	56.97	689.
JUL	940.	393.	815.11	827.46	814.64	364935.	0.	0.	17096000.	22978.	58.43	707.
AUG	1218.	389.	843.14	858.83	842.68	415895.	0.	0.	17546200.	23583.	60.59	733.
SEP	872.	411.	866.44	874.05	865.96	443302.	0.	0.	18446000.	25619.	62.27	753.
OCT	652.	419.	877.92	881.79	877.43	457581.	0.	0.	19705200.	26485.	63.09	763.
NOV	623.	459.	884.22	886.64	883.68	467297.	0.	0.	21032600.	29212.	63.94	768.
DEC	89.	459.	880.69	874.74	880.15	444536.	0.	0.	21618100.	29056.	63.27	765.
PROJECT NO 1				YEAR OF STUDY 2031								
JAN	92.	431.	868.94	863.14	868.45	423665.	0.	0.	20043300.	26940.	62.44	755.
FEB	39.	441.	856.94	850.73	856.44	401317.	0.	0.	18269400.	27180.	61.97	749.
MAR	25.	416.	842.94	835.14	842.46	377236.	0.	0.	18783000.	25246.	60.59	733.
APR	67.	421.	828.34	821.54	827.86	356163.	0.	0.	18041100.	25057.	59.49	719.
MAY	283.	402.	818.92	816.30	818.45	348823.	0.	0.	17591400.	23644.	58.76	710.
JUN	703.	394.	822.58	828.85	822.11	367171.	0.	0.	16781000.	23307.	59.05	714.
JUL	1011.	380.	841.08	853.31	840.62	405959.	0.	0.	17096000.	22978.	60.44	731.
AUG	1152.	378.	866.52	879.72	866.06	453511.	0.	0.	17546200.	23583.	62.28	753.
SEP	1001.	488.	887.36	895.00	886.74	484000.	5177.	4028260.	18446000.	25619.	63.88	772.
OCT	504.	503.	895.00	895.00	894.36	484000.	5661.	4404740.	19705200.	26485.	64.29	778.
NOV	323.	455.	893.41	891.03	892.88	476144.	0.	0.	21032600.	29212.	64.19	776.
DEC	171.	455.	887.07	882.31	886.54	458630.	0.	0.	21618100.	29056.	63.74	771.
PROJECT NO 1				YEAR OF STUDY 2032								
JAN	197.	426.	878.51	874.71	878.02	444495.	0.	0.	20043300.	26940.	63.10	763.
FEB	52.	435.	868.59	862.46	868.09	422435.	0.	0.	18917700.	27180.	62.41	755.
MAR	47.	410.	856.25	850.05	855.77	400098.	0.	0.	18783000.	25246.	61.52	744.
APR	118.	412.	844.26	838.47	843.78	382595.	0.	0.	18041100.	25057.	60.70	734.
MAY	292.	393.	836.52	834.58	836.06	376329.	0.	0.	17591400.	23644.	60.12	727.
JUN	515.	387.	836.95	839.31	836.48	383910.	0.	0.	16781000.	23307.	60.13	727.
JUL	816.	377.	847.68	856.05	847.22	410890.	0.	0.	17096000.	22978.	60.91	737.
AUG	992.	378.	866.52	877.00	866.07	448603.	0.	0.	17546200.	23583.	62.28	753.
SEP	964.	402.	885.51	894.02	885.04	480824.	0.	0.	18446000.	25619.	63.65	770.
OCT	526.	474.	894.51	895.00	893.92	484000.	3827.	2977900.	19705200.	26485.	64.27	777.
NOV	181.	456.	890.90	886.80	890.37	467617.	0.	0.	21032600.	29212.	64.01	774.
DEC	121.	458.	881.41	876.02	880.87	446047.	0.	0.	21618100.	29056.	63.33	766.

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

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NOTES:

1. STORAGE EOM EQUALS THE STORAGE IN THE RESERVOIR AT THE END OF THE MONTH.
2. WASTE IS THE NONUSABLE OUTFLOW WASTED OVER THE SPILLWAY.
3. YEARS ARE PROJECTED INTO THE ASSUMED TIME OF PROJECT OPERATION WITH 1983 EQUIVALENT TO THE FIRST YEAR OF PERIOD OF RECORD.
4. LONG LAKE PRODUCES 225 MILLION KWH/YEAR PRIMARY ENERGY AND 9.8 MILLION KWH/YEAR OF SECONDARY ENERGY WITHOUT BENEFIT OF RULE CURVE OPERATION. SEE PLATES 2 & 3 AND TABLES 6 & 10.

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM, ALASKA

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

DESIGNED:
DRAWN: T.S.
CHECKED:
PREPARED:
SUBMITTED: [signature] PE
APPROVED: [signature] LTC, CE
SCALE NONE
DATE AUGUST 1985
FILE NUMBER Q-4-5-113
SHEET 3 OF 3

Month	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT	STORAGE EOM AF	SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
PROJECT NO 2					YEAR OF STUDY 1983									
JAN	47.	425.	880.80	874.46	880.31	444028.	0.	0.	20043300.	26940.	63.32	766.	0.	.4
FEB	46.	514.	867.23	860.00	866.58	418000.	4358.	1285830.	18265400.	27180.	62.31	753.	0.	.6
MAR	47.	411.	853.62	847.24	853.14	395584.	0.	0.	18783000.	25246.	61.34	742.	0.	.4
APR	122.	434.	841.12	835.00	840.62	377001.	1178.	861595.	18041100.	25057.	60.44	731.	0.	.4
MAY	239.	395.	831.99	828.98	831.52	367374.	0.	0.	17591400.	23644.	59.77	723.	0.	.4
JUN	816.	387.	837.26	845.54	836.80	392873.	0.	0.	16781000.	23307.	60.15	727.	0.	.4
JUL	807.	374.	853.17	860.80	852.72	419451.	0.	0.	17096000.	22978.	61.31	741.	0.	.4
AUG	1011.	376.	871.52	882.23	871.06	458467.	0.	0.	17546200.	23583.	62.64	757.	0.	.4
SEP	982.	552.	888.61	895.00	887.89	484000.	9021.	7018460.	18446000.	25619.	63.96	774.	0.	.7
OCT	605.	604.	895.00	895.00	893.90	484000.	11860.	9223290.	19705200.	26485.	64.26	777.	0.	1.0
NOV	137.	456.	893.24	885.48	889.70	464978.	0.	0.	21032600.	29212.	63.96	773.	0.	.5
DEC	82.	459.	879.34	873.19	878.80	441743.	0.	0.	21618100.	29056.	63.18	764.	0.	.5
PROJECT NO 2					YEAR OF STUDY 1984									
JAN	83.	432.	867.22	861.25	866.73	420266.	0.	0.	20043300.	26940.	62.31	754.	0.	.4
FEB	123.	441.	856.16	851.07	855.66	401929.	0.	0.	18917700.	27180.	61.52	744.	0.	.4
MAR	49.	416.	843.77	836.46	843.29	379349.	0.	0.	18783000.	25246.	60.65	733.	0.	.4
APR	63.	420.	829.69	822.91	829.20	358078.	0.	0.	18041100.	25057.	59.59	721.	0.	.4
MAY	316.	401.	821.04	819.16	820.57	352836.	0.	0.	17591400.	23644.	58.92	712.	0.	.4
JUN	656.	393.	824.41	829.65	823.94	368446.	0.	0.	16781000.	23307.	59.20	716.	0.	.4
JUL	940.	380.	840.62	851.58	840.16	402855.	0.	0.	17096000.	22978.	60.40	730.	0.	.4
AUG	1218.	378.	865.90	880.22	865.45	454449.	0.	0.	17546200.	23583.	62.24	753.	0.	.4
SEP	872.	401.	887.37	894.51	886.90	482436.	0.	0.	18446000.	25619.	63.78	771.	0.	.4
OCT	652.	626.	894.75	895.00	893.50	484000.	13170.	10240300.	19705200.	26485.	64.23	777.	0.	1.2
NOV	623.	622.	895.00	895.00	893.77	484000.	10007.	7781180.	21032600.	29212.	64.23	777.	0.	1.2
DEC	89.	454.	889.37	883.75	888.85	461514.	0.	0.	21618100.	29056.	63.90	773.	0.	.5
PROJECT NO 2					YEAR OF STUDY 1985									
JAN	92.	426.	878.24	872.73	877.75	440923.	0.	0.	20043300.	26940.	63.10	763.	0.	.4
FEB	39.	451.	866.36	860.00	865.84	418001.	829.	624144.	18265400.	27180.	62.22	752.	0.	.5
MAR	25.	411.	853.19	846.38	852.71	394220.	0.	0.	18783000.	25246.	61.31	741.	0.	.4
APR	67.	415.	839.60	832.81	839.12	373505.	0.	0.	18041100.	25057.	60.35	730.	0.	.4
MAY	283.	396.	830.64	828.46	830.17	366544.	0.	0.	17591400.	23644.	59.67	722.	0.	.4
JUN	703.	388.	834.31	840.16	833.85	385234.	0.	0.	16781000.	23307.	59.93	725.	0.	.4
JUL	1011.	375.	851.83	863.51	851.38	424319.	0.	0.	17096000.	22978.	61.22	740.	0.	.4
AUG	1152.	374.	876.28	889.06	875.83	472132.	0.	0.	17546200.	23583.	62.99	762.	0.	.4
SEP	1001.	728.	892.03	895.00	889.99	484000.	19529.	15171400.	18446000.	25619.	64.09	775.	4352.	2.0
OCT	504.	503.	895.00	895.00	894.36	484000.	5661.	4404740.	19705200.	26485.	64.29	778.	0.	.6
NOV	323.	455.	893.41	891.83	892.88	476144.	0.	0.	21032600.	29212.	64.19	776.	0.	.5
DEC	171.	455.	887.07	882.31	886.54	458630.	0.	0.	21618100.	29056.	63.74	771.	0.	.5
PROJECT NO 2					YEAR OF STUDY 1986									
JAN	197.	426.	878.51	874.71	878.02	444493.	0.	0.	20043300.	26940.	63.10	763.	0.	.4
FEB	52.	529.	867.35	860.00	866.68	418000.	5160.	3891110.	18265400.	27180.	62.32	754.	0.	.6
MAR	47.	411.	853.62	847.24	853.14	395584.	0.	0.	18783000.	25246.	61.34	742.	0.	.4
APR	118.	430.	841.12	835.00	840.63	377001.	940.	687521.	18041100.	25057.	60.44	731.	0.	.4
MAY	292.	395.	833.02	831.04	832.55	370667.	0	0.	17591400.	23644.	59.85	724.	0.	.4
JUN	515.	389.	833.37	835.71	832.91	378143.	0.	0.	16781000.	23307.	59.86	724.	0.	.4
JUL	816.	378.	844.25	852.79	843.79	405029.	0.	0.	17096000.	22978.	60.67	734.	0.	.4
AUG	992.	380.	863.24	873.69	862.78	442653.	0.	0.	17546200.	23583.	62.04	750.	0.	.4
SEP	944.	404.	882.18	890.67	881.70	474782.	0.	0.	18446000.	25619.	63.40	767.	0.	.4
OCT	526.	412.	892.48	894.30	892.00	481736.	0.	0.	19705200.	26485.	64.14	775.	0.	.4
NOV	181.	456.	889.98	885.66	889.44	465324.	0.	0.	21032600.	29212.	63.94	773.	0.	.5
DEC	121.	455.	880.19	874.73	879.65	444515.	0.	0.	21618100.	29056.	63.24	765.	0.	.5
PROJECT NO 2					YEAR OF STUDY 1987									
JAN	170.	430.	870.27	865.81	869.78	428469.	0.	0.	20043300.	26940.	62.51	756.	0.	.4
FEB	90.	439.	860.42	855.03	859.92	409855.	0.	0.	18265400.	27180.	61.82	748.	0.	.4
MAR	43.	419.	847.95	840.07	847.47	386221.	0.	0.	18783000.	25246.	60.93	737.	0.	.4
APR	49.	418.	833.95	827.03	833.46	362249.	0.	0.	18041100.	25057.	59.90	724.	0.	.4
MAY	222.	400.	823.26	819.50	822.79	353299.	0.	0.	17591400.	23644.	59.09	715.	0.	.4
JUN	548.	394.	822.69	825.89	822.23	362428.	0.	0.	16781000.	23307.	59.06	714.	0.	.4
JUL	867.	382.	835.50	845.12	835.04	392196.	0.	0.	17096000.	22978.	60.01	726.	0.	.4
AUG	1133.	382.	858.21	871.30	857.75	438353.	0.	0.	17546200.	23583.	61.68	746.	0.	.4
SEP	605.	407.	875.62	877.83	876.09	450098.	0.	0.	18446000.	25619.	62.85	760.	0.	.4
OCT	381.	420.	877.16	876.50	876.68	447700.	0.	0.	19705200.	26485.	63.05	763.	0.	.4
NOV	247.	465.	872.88	869.26	872.32	436679.	0.	0.	21032600.	29212.	62.71	758.	0.	.5
DEC	57.	469.	862.23	855.19	861.66	409346.	0.	0.	21618100.	29056.	61.95	749.	0.	.5
PROJECT NO 2					YEAR OF STUDY 1988									
JAN	66.	442.	847.98	840.78	847.48	386097.	0.	0.	20043300.	26940.	60.93	737.	0.	.4
FEB	90.	453.	834.20	827.61	833.67	365186.	0.	0.	18917700.	27180.	59.92	725.	0.	.5
MAR	65.	429.	819.55	811.49	819.06	342192.	0.	0.	18783000.	25246.	58.81	711.	0.	.4
APR	104.	435.	803.99	796.49	803.49	323086.	0.	0.	18041100.	25057.	57.57	696.	0.	.4
MAY	366.	416.	795.34	796.19	794.86	320030.	0.	0.	17591400.	23644.	56.87	688.	0.	.4
JUN	675.	407.	800.29	806.40	799.82	335965.	0.	0.	16781000.	23307.	57.23	692.	0.	.4
JUL	804.	392.	815.77	825.15	815.31	361247.	0.	0.	17096000.	22978.	58.49	707.	0.	.4
AUG	809.	394.	833.20	841.25	832.74	386759.	0.	0.	17546200.	23583.	59.84	724.	0.	.4
SEP	670.	421.	846.06	850.86	845.57	401552.	0.	0.	18446000.	25619.	60.79	735.	0.	.4
OCT	608.	430.	855.25	859.64	854.76	417360.	0.	0.	19705200.	26485.	61.44	743.	0.	.4
NOV	190.	475.	855.02	850.40	854.43	400719.	0.	0.	21032600.	29212.	61.41	743.	0.	.5
DEC	263.	477.	846.09	841.78	845.49	387503.	0.	0.	21618100.	29056.	60.79	735.	0.	.5
PROJECT NO 2					YEAR OF STUDY 1989									
JAN	86.	449.	834.69	827.60	834.18	365169.	0.	0.	20043300.	26940.	59.96	725.	0.	.5
FEB	26.	442.	818.81	810.02	818.28	341034.	0.	0.	18265400.	27180.	58.75	710.	0.	.5
MAR	24.	440.	800.18	790.34	799.68	315410.	0.	0.	18783000.	25246.	57.28	693.	0.	.5
APR	110.	448.	782.36	774.38	781.85	295266.	0.	0.	18041100.	25057.	55.86	675.	0.	.5
MAY	382.	428.	773.18	771.98	772.69	292380.	0.	0.	17591400.	23644.	55.12	666.	0.	.5
JUN	666.	420.	777.91	783.85	777.43	307011.	0.	0.	16781000.	23307.	55.47	671.	0.	.5
JUL	791.	406.	796.81	805.77	796.33	335081.	0.	0.	17096000.	22978.	56.81	687.	0.	.5
AUG	992.	401.	818.62	831.48	818.15	371372.	0.	0.	17546200.	23583.	58.81	711.	0.	.4
SEP	783.	425.	838.44	845.41	837.95	392657.	0.	0.	18446000.	25619.	60.24	728.	0.	.4
OCT	450.	435.	845.68	845.95	845.18	393529.	0.	0.	19705200.	26485.	60.77	735.	0.	.5
NOV	494.	480.	846.20	846.46	845.60	394336.	0.	0.	21032600.	29212.	60.80	735.	0.	.6
DEC	98.	481.	838.77	831.08	838.16	370730.	0.	0.	21618100.	29056.	60.29	729.	0.	.6
PROJECT NO 2					YEAR OF STUDY 1990									
JAN	55.	456.	822.75	819.42	822.22	346311.	0.	0.	20043300.	26940.	59.06	714.	0.	.5
FEB	80.	470.	806.00	797.57	805.42	324609.	0.	0.	18265400.	27180.	57.73	698.	0.	.5
MAR	110.	467.	789.50	781.43	789.00	303864.	0.	0.	18783000.	25246.	56.42	682.	0.	.5
APR	169.	451.	774.31	767.20	773.79	286923.	0.	0.	18041100.	25057.	55.22	668.	0.	.5
MAY	412.	433.	766.61	766.02	766.12	285630.	0.	0.	17591400.	23644.	54.60	660.	0.	.5
JUN	684.	423.	772.65	779.28	772.17	301141.	0.	0.	16781000.	23307.	55.05	666.	0.	.5
JUL	878.	406.	790.52	801.75	790.04	330105.	0.	0.	17096000.	22978.	56.46	683.	0.	.5
AUG	919.	406.	813.61	825.46	813.13	361743.	0.	0.	17546200.	23583.	58.31	705.	0.	.5
SEP	1077.	425.	837.87	850.28	837.38	403504.	0.	0.	18446000.	25619.	60.28	728.	0.	.5
OCT	532.	432.	851.97	853.67	851.48	406617.	0.	0.	19705200.	26485.	61.22	740.	0.	.5
NOV	492.	476.	853.94	854.20	853.35	407564.	0.	0.	21032600.	29212.	61.36	742.	0.	.5
DEC	209.	476.	849.29	844.38	848.70	391139.	0.	0.	21618100.	29056.	61.02	738.	0.	.5
PROJECT NO 2					YEAR OF STUDY 1991									
JAN	74.	447.	836.92	829.47	836.42	368151.	0.	0.	20043300.	26940.	60.15	727.	0.	.5
FEB	47.	460.	821.46	813.46	820.92	345160.	0.	0.	18265400.	27180.	58.96	713.	0.	.5
MAR	85.	437.	805.11	796.76	804.62	323470.	0.	0.	18783000.	25246.	57.66	697.	0.	.5
APR	127.	444.	789.38	782.00	788.88	304600.	0.	0.	18041100.	25057.	56.41	682.	0.	.5
MAY	543.	421.	784.86	787.72	784.37	312047.	0.	0.	17591400.	23644.	56.06	678.	0.	.5
JUN	859.	408.	798.10	808.47	797.62	338861.	0.	0.	16781000.	23307.	57.07	690.	0.	.5
JUL	1105.	388.	823.58	838.68	823.11	382901.	0.	0.	17096000.	22978.	59.10	715.	0.	.4
AUG	992.	386.	849.94	861.19	849.48	420156.	0.	0.	17546200.	23583.	61.08	739.	0.	.4
SEP	1020.	409.	871.22	881.25	870.75	456505.	0.	0.	18446000.	25619.	62.62	757.	0.	.4
OCT	467.	417.	882.00	882.76	881.52	459527.	0.	0.	19705200.	26485.	63.38	766.	0.	.4
NOV	316.	461.	880.50	878.25	879.95	450855.	0.	0.	21032600.	29212.	63.26	765.	0.	.5
DEC	264.	462.	874.86	871.48	874.31	438664.	0.	0.	21618100.	29056.	62.85	760.	0.	.5
PROJECT NO 2					YEAR OF STUDY 1992									
JAN	95.	433.	865.70	859.93	865.21	417878.	0.	0.	20043300.	26940.	62.20	752.	0.	.4
FEB	76.	442.	853.95	847.98	853.45	396772.	0.	0.	18917700.	27180.	61.36	742.	0.	.4
MAR	59.	417.	840.77	833.57	840.29	374718.	0.	0.	18783000.	25246.	60.44	731.	0.	.4
APR	112.	421.	827.60	821.64	827.12	356300.	0.	0.	18041100.	25057.	59.44	719.	0.	.4
MAY	432.	400.	822.33	823.03	821.86	358242.	0.	0.	17591400.	23644.	59.04	714.	0.	.4
JUN	843.	390.	831.58	840.13	831.11	385181.	0.	0.	16781000.	23307.	59.72	722.	0.	.4
JUL	907.	376.	850.01	859.90	849.56	417821.	0.	0.	17096000.	22978.	61.08	739.	0.	.4
AUG	912.	377.	869.02	878.15	868.57	450681.	0.	0.	17546200.	23583.	62.46	755.	0.	.4
SEP	907.	402.	886.07	893.99	885.60	480715.	0.	0.	18446000.	25619.	63.69	770.	0.	.4
OCT	328.	412.	892.63	891.28	892.15	475498.	0.	0.	19705200.	26485.	64.15	776.	0.	.4
NOV	119.	458.	885.96	880.63	885.42	455276.	0.	0.	21032600.	29212.	63.65	770.	0.	.5
DEC	47.	462.	873.56	866.90	873.01	429701.	0.	0.	21618100.	29056.	62.76	759.	0.	.5

Month	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT
PROJECT NO 2				YEAR OF STUDY	
JAN	176.	435.	862.07	857.65	861.58
FEB	129.	443.	852.66	847.68	852.16
MAR	114.	417.	841.54	835.40	841.06
APR	207.	419.	831.45	827.50	830.96
MAY	523.	396.	829.92	832.35	829.45
JUN	770.	386.	839.80	847.24	839.34
JUL	1020.	372.	858.46	869.67	858.01
AUG	838.	373.	877.32	884.97	876.87
SEP	785.	448.	889.98	895.00	889.48
OCT	496.	495.	895.00	895.00	894.37
NOV	344.	454.	893.96	892.92	893.43
DEC	297.	454.	889.89	886.87	889.37
PROJECT NO 2				YEAR OF STUDY	
JAN	186.	555.	880.93	875.00	880.19
FEB	40.	526.	867.90	860.00	866.83
MAR	99.	456.	853.75	847.50	853.21
APR	78.	414.	840.93	834.36	840.45
MAY	329.	394.	833.09	831.82	832.63
JUN	780.	386.	839.46	847.09	839.00
JUL	836.	373.	855.14	863.20	854.69
AUG	790.	377.	870.25	877.30	869.80
SEP	712.	404.	882.02	886.73	881.54
OCT	1020.	728.	890.86	895.00	888.82
NOV	459.	458.	895.00	895.00	894.46
DEC	136.	454.	890.10	885.21	889.58
PROJECT NO 2				YEAR OF STUDY	
JAN	19.	426.	878.53	871.86	878.04
FEB	42.	436.	865.77	859.68	865.27
MAR	57.	411.	853.47	847.26	852.99
APR	128.	440.	841.13	835.00	840.63
MAY	299.	394.	833.15	831.31	832.69
JUN	672.	387.	836.73	842.15	836.27
JUL	850.	375.	850.84	859.54	850.39
AUG	1020.	376.	870.45	881.35	869.99
SEP	774.	401.	887.39	893.42	886.92
OCT	518.	434.	894.21	895.00	893.71
NOV	529.	528.	895.00	895.00	894.33
DEC	311.	473.	892.50	890.00	891.91
PROJECT NO 2				YEAR OF STUDY	
JAN	144.	615.	882.50	875.00	881.33
FEB	250.	719.	867.50	860.00	865.54
MAR	49.	411.	853.66	847.31	853.18
APR	117.	431.	841.16	835.00	840.67
MAY	462.	462.	835.00	835.00	834.45
JUN	908.	521.	842.50	850.00	841.84
JUL	902.	372.	859.05	868.10	858.60
AUG	1029.	375.	878.77	889.44	878.31
SEP	775.	588.	892.22	895.00	891.24
OCT	651.	650.	895.00	895.00	893.57
NOV	171.	456.	890.75	886.50	890.22
DEC	80.	459.	880.39	874.27	879.85
PROJECT NO 2				YEAR OF STUDY	
JAN	52.	432.	867.78	861.29	867.29
FEB	52.	442.	855.22	849.15	854.72
MAR	57.	417.	841.92	834.69	841.44
APR	102.	421.	828.60	822.51	828.12
MAY	337.	401.	821.10	819.69	820.63
JUN	714.	393.	825.99	832.29	825.53
JUL	775.	380.	840.18	848.07	839.72
AUG	828.	383.	855.77	863.47	855.31
SEP	920.	408.	871.90	880.33	871.43
OCT	660.	416.	884.07	887.81	883.59
NOV	115.	460.	882.53	877.25	881.99
DEC	70.	464.	870.51	863.77	869.96
PROJECT NO 2				YEAR OF STUDY	
JAN	42.	437.	857.02	850.27	856.52
FEB	38.	448.	842.84	835.42	842.33
MAR	39.	424.	827.70	819.98	827.21
APR	284.	427.	816.83	813.68	816.34
MAY	509.	403.	816.08	818.49	815.61
JUN	568.	394.	822.11	825.74	821.65
JUL	763.	384.	833.04	840.34	832.58
AUG	788.	386.	847.99	855.63	847.53
SEP	576.	415.	858.29	860.94	857.81
OCT	511.	427.	862.37	863.80	861.88
NOV	425.	470.	863.04	862.28	862.47
DEC	109.	472.	856.07	849.86	855.49
PROJECT NO 2				YEAR OF STUDY	
JAN	24.	445.	841.45	833.04	840.95
FEB	35.	450.	825.21	817.37	824.67
MAR	48.	435.	808.14	798.91	807.65
APR	90.	443.	790.78	782.65	790.28
MAY	287.	425.	779.22	775.79	778.73
JUN	805.	415.	785.02	794.25	784.56
JUL	833.	399.	804.54	814.82	804.07
AUG	1173.	395.	830.72	846.62	830.25
SEP	763.	418.	852.51	858.40	852.03
OCT	661.	427.	862.39	866.38	861.90
NOV	238.	471.	862.52	858.66	861.95
DEC	180.	473.	853.56	848.45	852.97
PROJECT NO 2				YEAR OF STUDY	
JAN	43.	445.	840.39	832.34	839.89
FEB	28.	459.	824.00	815.66	823.46
MAR	55.	436.	806.56	797.46	806.07
APR	87.	444.	789.19	780.91	788.69
MAY	263.	426.	776.76	772.60	776.27
JUN	604.	420.	777.08	781.56	776.60
JUL	1143.	402.	799.20	816.84	798.73
AUG	888.	397.	826.78	836.72	826.31
SEP	627.	423.	840.80	844.89	840.32
OCT	619.	434.	848.33	851.77	847.83
NOV	174.	480.	845.87	839.97	845.27
DEC	271.	483.	835.88	831.80	835.28
PROJECT NO 2				YEAR OF STUDY	
JAN	46.	455.	823.26	814.73	822.73
FEB	38.	471.	805.44	796.16	804.87
MAR	57.	449.	786.62	777.09	786.11
APR	142.	457.	768.89	760.68	768.35
MAY	478.	435.	761.86	763.03	761.36
JUN	944.	421.	775.91	788.79	775.43
JUL	892.	401.	800.48	812.17	800.01
AUG	797.	400.	820.76	829.36	820.29
SEP	1018.	424.	840.60	851.84	840.12
OCT	1486.	423.	869.58	887.32	869.10
NOV	715.	456.	891.16	895.00	890.62
DEC	367.	529.	892.50	890.00	891.83
PROJECT NO 2				YEAR OF STUDY	
JAN	68.	539.	882.50	875.00	881.81
FEB	44.	530.	867.50	860.00	866.82
MAR	63.	420.	853.75	847.50	853.26
APR	110.	429.	841.25	835.00	840.76
MAY	312.	394.	833.41	831.81	832.94
JUN	905.	432.	840.91	850.00	840.41
JUL	761.	373.	856.62	863.24	856.16
AUG	875.	376.	871.74	880.25	871.29
SEP	1011.	515.	887.62	895.00	886.97
OCT	1237.	727.	895.00	895.00	892.97
NOV	246.	455.	891.87	888.75	891.34
DEC	163.	457.	884.21	879.67	883.60

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

RULE CURVE OPERATION

SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
0.	0.	20043300.	26940.	61.92	749.	0.	.4
0.	0.	18265400.	27180.	61.24	741.	0.	.4
0.	0.	18783000.	25246.	60.50	732.	0.	.4
0.	0.	18041100.	25057.	59.72	722.	0.	.4
0.	0.	17591400.	23644.	59.59	721.	0.	.4
0.	0.	16781000.	23307.	60.34	730.	0.	.4
0.	0.	17096000.	22978.	61.70	746.	0.	.4
0.	0.	17546200.	23583.	63.06	763.	0.	.4
2830.	2202300.	18446000.	25619.	64.01	774.	0.	.5
5169.	4021980.	19705200.	26485.	64.29	778.	0.	.6
0.	0.	21032600.	29212.	64.23	777.	0.	.5
0.	0.	21618100.	29056.	63.97	774.	0.	.5
8011.	6135720.	20043300.	26940.	63.29	765.	0.	.7
5005.	3774840.	18265400.	27180.	62.33	754.	0.	.6
2796.	2076420.	18783000.	25246.	61.37	742.	0.	.5
0.	0.	18041100.	25057.	60.45	731.	0.	.4
0.	0.	17591400.	23644.	59.86	724.	0.	.4
0.	0.	16781000.	23307.	60.32	729.	0.	.4
0.	0.	17096000.	22978.	61.46	743.	0.	.4
0.	0.	17546200.	23583.	62.54	756.	0.	.4
0.	0.	18446000.	25619.	63.39	767.	0.	.4
19350.	15032800.	19705200.	26485.	64.05	775.	1368.	2.0
280.	217888.	21032600.	29212.	64.30	778.	0.	.5
0.	0.	21618100.	29056.	63.95	773.	0.	.5
0.	0.	20043300.	26940.	63.12	763.	0.	.4
0.	0.	18265400.	27180.	62.21	752.	0.	.4
0.	0.	18783000.	25246.	61.33	742.	0.	.4
1572.	1149800.	18041100.	25057.	60.44	731.	0.	.4
0.	0.	17591400.	23644.	59.86	724.	0.	.4
0.	0.	16781000.	23307.	60.11	727.	0.	.4
0.	0.	17096000.	22978.	61.14	739.	0.	.4
0.	0.	17546200.	23583.	62.56	757.	0.	.4
0.	0.	18446000.	25619.	63.78	771.	0.	.4
1365.	1062250.	19705200.	26485.	64.23	777.	0.	.4
4442.	3456130.	21032600.	29212.	64.29	777.	0.	.6
1269.	984892.	21618100.	29056.	64.14	776.	0.	.5
11724.	8992350.	20043300.	26940.	63.38	767.	0.	1.1
16261.	12249400.	18917790.	27180.	62.23	753.	0.	1.9
0.	0.	18783000.	25246.	61.34	742.	0.	.4
1006.	735825.	18041100.	25057.	60.44	731.	0.	.4
4173.	3029020.	17591400.	23644.	59.98	725.	0.	.5
8127.	5954650.	16781000.	23307.	60.55	732.	0.	.6
0.	0.	17096000.	22978.	61.74	747.	0.	.4
0.	0.	17546200.	23583.	63.16	764.	0.	.4
11225.	8730720.	18446000.	25619.	64.15	776.	0.	.9
14672.	11405900.	19705200.	26485.	64.23	777.	0.	1.4
0.	0.	21032600.	29212.	64.00	774.	0.	.5
0.	0.	21618100.	29056.	63.25	765.	0.	.5
0.	0.	20043300.	26940.	62.35	754.	0.	.4
0.	0.	18269400.	27180.	61.45	743.	0.	.4
0.	0.	18783000.	25246.	60.52	732.	0.	.4
0.	0.	18041100.	25057.	59.51	720.	0.	.4
0.	0.	17591400.	23644.	58.93	713.	0.	.4
0.	0.	16781000.	23307.	59.29	717.	0.	.4
0.	0.	17096000.	22978.	60.37	730.	0.	.4
0.	0.	17546200.	23583.	61.50	744.	0.	.4
0.	0.	18446000.	25619.	62.06	750.	0.	.4
0.	0.	19709200.	26485.	63.54	768.	0.	.4
0.	0.	21032600.	29212.	63.41	767.	0.	.5
0.	0.	21618100.	29056.	62.54	756.	0.	.5
0.	0.	20043300.	26940.	61.58	745.	0.	.4
0.	0.	18265400.	27180.	60.59	733.	0.	.5
0.	0.	18783000.	25246.	59.45	719.	0.	.4
0.	0.	18041100.	25057.	58.59	708.	0.	.4
0.	0.	17591400.	23644.	58.54	708.	0.	.4
0.	0.	16781000.	23307.	59.02	714.	0.	.4
0.	0.	17096000.	22978.	59.83	723.	0.	.4
0.	0.	17546200.	23583.	60.94	737.	0.	.4
0.	0.	18446000.	25619.	61.68	746.	0.	.4
0.	0.	19705200.	26485.	61.97	749.	0.	.4
0.	0.	21032600.	29212.	62.04	750.	0.	.5
0.	0.	21618100.	29056.	61.51	744.	0.	.5
0.	0.	20043300.	26940.	60.48	731.	0.	.4
0.	0.	18265400.	27180.	59.23	716.	0.	.5
0.	0.	18783000.	25246.	57.91	700.	0.	.4
0.	0.	18041100.	25057.	56.52	684.	0.	.4
0.	0.	17591400.	23644.	55.60	672.	0.	.4
0.	0.	16781000.	23307.	56.03	678.	0.	.4
0.	0.	17096000.	22978.	57.58	696.	0.	.4
0.	0.	17546200.	23583.	59.64	721.	0.	.4
0.	0.	18446000.	25619.	61.26	741.	0.	.4
0.	0.	19705200.	26485.	61.97	749.	0.	.4
0.	0.	21032600.	29212.	61.96	749.	0.	.5
0.	0.	21618100.	29056.	61.30	741.	0.	.5
0.	0.	20043300.	26940.	60.41	731.	0.	.4
0.	0.	18917700.	27180.	59.15	715.	0.	.5
0.	0.	18783000.	25246.	57.78	699.	0.	.4
0.	0.	18041100.	25057.	56.40	682.	0.	.4
0.	0.	17591400.	23644.	55.41	670.	0.	.4
0.	0.	16781000.	23307.	55.39	670.	0.	.4
0.	0.	17096000.	22978.	57.14	691.	0.	.4
0.	0.	17546200.	23583.	59.35	718.	0.	.4
0.	0.	18446000.	25619.	60.44	731.	0.	.4
0.	0.	19705200.	26485.	60.96	737.	0.	.4
0.	0.	21032600.	29212.	60.80	735.	0.	.6
0.	0.	21618100.	29056.	60.06	726.	0.	.6
0.	0.	20043300.	26940.	59.09	715.	0.	.5
0.	0.	18269400.	27180.	57.69	698.	0.	.5
0.	0.	18783000.	25246.	56.20	680.	0.	.5
0.	0.	18041100.	25057.	54.80	663.	0.	.5
0.	0.	17591400.	23644.	54.23	656.	0.	.4
0.	0.	16781000.	23307.	55.30	669.	0.	.4
0.	0.	17096000.	22978.	57.25	692.	0.	.4
0.	0.	17546200.	23583.	58.89	712.	0.	.4
0.	0.	18446000.	25619.	60.40	730.	0.	.4
0.	0.	19705200.	26485.	62.51	756.	0.	.4
49.	38130.	21032600.	29212.	64.04	774.	0.	.5
4708.	3653420.	21618100.	29056.	64.13	775.	0.	.6
7059.	5415980.	20043300.	26940.	63.40	767.	0.	.6
5227.	3942290.	18265400.	27180.	62.33	754.	0.	.6
560.	415520.	18783000.	25246.	61.32	741.	0.	.4
884.	646661.	18041100.	25057.	60.45	731.	0.	.4
0.	0.	17591400.	23644.	59.88	724.	0.	.4
2813.	2057140.	16781000.	23307.	60.43	731.	0.	.4
0.	0.	17096000.	22978.	61.56	744.	0.	.4
0.	0.	17546200.	23583.	62.65	758.	0.	.4
6757.	5257440.	18446000.	25619.	63.89	773.	0.	.6
19350.	15032800.	19705200.	26485.	64.21	777.	31354.	2.0
0.	0.	21032600.	29212.	64.08	775.	0.	.5
0.	0.	21618100.	29056.	63.53	768.	0.	.5

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DRAWN: L.N.

SNETTISHAM, ALASKA

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

SCALE NONE | DATE AUGUST 1968

FILE NUMBER Q-4-5-113

SHEET 1 OF 3

DESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 9

	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT	STORAGE EOM AF	SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
PROJECT NO 2					YEAR OF STUDY 2003									
JAN	127.	428.	874.52	869.37	874.03	434867.	0.	0.	20043300.	26940.	62.84	760.	0.	.4
FEB	125.	437.	864.54	859.72	864.05	417499.	0.	0.	18265400.	27180.	62.09	751.	0.	.4
MAR	135.	484.	853.61	847.50	853.00	396001.	4493.	3334680.	18783000.	25246.	61.33	742	0.	.4
APR	93.	414.	841.21	834.92	840.73	376882.	67.	49400.	18041100.	25057.	60.64	733.	0.	.4
MAY	557.	555.	834.96	835.00	834.28	377001.	8665.	6289530.	17591400.	23644.	59.98	725.	0.	.6
JUN	704.	385.	841.23	847.46	840.77	395950.	0.	0.	16781000.	23307.	60.49	731.	0.	.4
JUL	839.	373.	855.53	863.64	855.10	424560.	0.	0.	17096000.	22978.	61.49	744.	0.	.4
AUG	720.	377.	869.49	875.34	869.04	445626.	0.	0.	17546200.	23583.	62.49	756.	0.	.4
SEP	1149.	504.	885.17	895.00	884.53	484000.	6027.	4689540.	18446000.	25619.	63.74	771.	0.	.6
OCT	720.	719.	895.00	895.00	893.05	484000.	18915.	14695600.	19705200.	26485.	64.22	777.	0.	1.9
NOV	237.	456.	891.44	887.08	890.91	469776.	0.	0.	21032600.	29212.	64.05	775.	0.	.5
DEC	183.	457.	883.63	879.38	883.10	452089.	0.	0.	21618100.	29056.	63.49	768.	0.	.5
PROJECT NO 2					YEAR OF STUDY 2004									
JAN	72.	429.	873.62	867.06	873.11	432160.	0.	0.	20043300.	26940.	62.77	759.	0.	.4
FEB	75.	436.	862.05	856.24	861.55	411255.	0.	0.	18917700.	27180.	61.96	749.	0.	.4
MAR	[illegible]	413.	849.57	842.90	849.09	389061.	0.	0.	18783000.	25246.	61.03	738.	0.	.4
APR	102.	416.	836.87	830.81	836.39	370341.	0.	0.	18041100.	25057.	60.14	727.	0.	.4
MAY	330.	396.	829.71	828.58	829.24	366735.	0.	0.	17591400.	23644.	59.60	721.	0.	.4
JUN	749.	388.	835.43	842.28	834.96	388194.	0.	0.	16781000.	23307.	60.01	726.	0.	.4
JUL	1001.	374.	853.56	864.84	853.10	426712.	0.	0.	17096000.	22978.	61.34	742.	0.	.4
AUG	1254.	486.	877.42	890.00	876.81	474001.	6817.	5200440.	17546200.	23583.	63.04	762.	0.	.4
SEP	786.	617.	892.50	895.00	890.46	484000.	12988.	10099500.	18446000.	25619.	64.15	770.	0.	1.1
OCT	808.	727.	895.00	895.00	892.97	484000.	19350.	15032800.	19705200.	26485.	64.21	777.	4975.	2.0
NOV	382.	454.	894.33	893.61	893.81	479676.	0.	0.	21032600.	29212.	64.24	777.	0.	.5
DEC	244.	454.	890.05	886.45	889.52	466804.	0.	0.	21618100.	29056.	63.84	773.	0.	.5
PROJECT NO 2					YEAR OF STUDY 2005									
JAN	74.	429.	880.71	875.00	880.22	445001.	236.	182236.	20043300.	26940.	63.20	763.	0.	.4
FEB	109.	595.	867.50	860.00	866.47	418001.	8832.	6659700.	18265400.	27180.	62.31	754.	0.	1.0
MAR	51.	411.	853.69	847.39	853.21	395833.	33.	24690.	18783000.	25246.	61.42	743.	0.	.4
APR	146.	462.	841.19	835.00	840.64	377001.	2857.	2080840.	18041100.	25057.	60.45	731.	0.	.5
MAY	501.	501.	835.00	835.00	834.37	377001.	6571.	4769640.	17591400.	23644.	59.98	725.	0.	.6
JUN	727.	385.	841.66	848.33	841.20	397330.	0.	0.	16781000.	23307.	60.48	731.	0.	.4
JUL	944.	372.	858.18	868.03	857.73	432468.	0.	0.	17096000.	22978.	61.68	746.	0.	.4
AUG	1162.	486.	879.01	890.00	878.40	474001.	6958.	5317620.	17546200.	23583.	63.16	764.	0.	.4
SEP	946.	728.	892.50	895.00	890.46	484000.	19520.	15171400.	18446000.	25619.	64.11	775.	2959.	2.0
OCT	689.	688.	895.00	895.00	893.30	484000.	17009.	13210700.	19705200.	26485.	64.22	777.	0.	1.6
NOV	205.	456.	891.26	887.52	890.73	469056.	0.	0.	21032600.	29212.	64.04	774.	0.	.5
DEC	108.	458.	881.96	876.39	881.42	447504.	0.	0.	21618100.	29056.	63.97	766.	0.	.5
PROJECT NO 2					YEAR OF STUDY 2006									
JAN	44.	431.	869.78	863.17	869.29	423706.	0.	0.	20043300.	26940.	62.50	756.	0.	.4
FEB	73.	441.	857.49	851.81	856.99	403262.	0.	0.	18265400.	27180.	61.61	745.	0.	.4
MAR	64.	415.	844.85	837.89	844.37	381637.	0.	0.	18783000.	25246.	60.72	734.	0.	.4
APR	195.	418.	833.74	829.59	833.26	368350.	0.	0.	18041100.	25057.	59.90	724.	0.	.4
MAY	424.	396.	830.11	830.64	829.64	370032.	0.	0.	17591400.	23644.	59.61	721.	0.	.4
JUN	807.	386.	838.77	846.90	838.31	395039.	0.	0.	16781000.	23307.	60.26	729.	0.	.4
JUL	954.	373.	856.99	867.08	856.53	430740.	0.	0.	17096000.	22978.	61.59	745.	0.	.4
AUG	640.	376.	871.59	876.09	871.13	446963.	0.	0.	17546200.	23583.	62.64	757.	0.	.4
SEP	471.	406.	877.15	878.22	876.68	450806.	0.	0.	18446000.	25619.	63.03	762.	0.	.4
OCT	624.	418.	881.48	884.73	880.99	463468.	0.	0.	19705200.	26485.	63.35	766.	0.	.4
NOV	416.	459.	884.08	883.43	883.54	460870.	0.	0.	21032600.	29212.	63.55	768.	0.	.5
DEC	203.	459.	879.23	875.04	878.69	445073.	0.	0.	21618100.	29056.	63.17	764.	0.	.5
PROJECT NO 2					YEAR OF STUDY 2007									
JAN	98.	431.	869.34	863.65	868.85	424583.	0.	0.	20043300.	26940.	62.66	755.	0.	.4
FEB	95.	440.	858.32	852.99	857.82	405385.	0.	0.	18265400.	27180.	61.67	746.	0.	.4
MAR	104.	414.	846.95	840.91	846.47	386280.	0.	0.	18783000.	25246.	60.87	736.	0.	.4
APR	120.	417.	839.32	829.73	834.84	360579.	0.	0.	18041100.	25057.	60.01	726.	0.	.4
MAY	408.	396.	829.95	830.17	829.48	369286.	0.	0.	17591400.	23644.	59.63	721.	0.	.4
JUN	887.	386.	839.80	849.42	839.34	399084.	0.	0.	16781000.	23307.	60.54	730.	0.	.4
JUL	1130.	829.	859.71	870.00	859.04	436001.	9691.	7243070.	17096000.	22978.	61.76	747.	0.	.6
AUG	1117.	499.	880.00	890.00	879.37	474001.	7749.	5928700.	17546200.	23583.	63.23	765.	0.	.6
SEP	866.	697.	892.50	895.00	890.73	484000.	17734.	13781000.	18446000.	25619.	64.13	775.	0.	1.7
OCT	786.	727.	895.00	895.00	892.97	484000.	19350.	15032800.	19705200.	26485.	64.21	777.	3622.	2.0
NOV	161.	454.	890.60	886.20	890.07	466418.	0.	0.	21032600.	29212.	63.99	774.	0.	.5
DEC	107.	459.	880.53	874.86	879.99	444759.	0.	0.	21618100.	29056.	63.26	765.	0.	.5
PROJECT NO 2					YEAR OF STUDY 2008									
JAN	110.	431.	869.58	863.89	868.89	425008.	0.	0.	20043300.	26940.	62.47	755.	0.	.4
FEB	61.	440.	857.82	851.75	857.32	403153.	0.	0.	18917700.	27180.	61.64	745.	0.	.4
MAR	93.	415.	845.35	838.95	844.87	383327.	0.	0.	18783000.	25246.	60.76	735.	0.	.4
APR	219.	417.	835.26	831.57	834.78	371517.	0.	0.	18041100.	25057.	60.01	726.	0.	.4
MAY	425.	395.	832.13	832.70	831.66	373323.	0.	0.	17591400.	23644.	59.76	723.	0.	.4
JUN	751.	386.	839.79	846.89	839.33	395028.	0.	0.	16781000.	23307.	60.34	730.	0.	.4
JUL	1110.	443.	858.44	870.00	857.94	436001.	4385.	3274510.	17096000.	22978.	61.71	746.	0.	.4
AUG	982.	372.	879.86	889.72	879.40	473454.	0.	0.	17546200.	23583.	63.24	765.	0.	.4
SEP	1129.	728.	892.36	895.00	890.32	484000.	19528.	15171400.	18446000.	25619.	64.11	775.	13298.	2.0
OCT	1275.	727.	895.00	895.00	892.97	484000.	19350.	15032800.	19705200.	26485.	64.21	777.	33690.	2.0
NOV	425.	454.	894.73	894.46	894.20	482260.	0.	0.	21032600.	29212.	64.30	778.	0.	.5
DEC	398.	492.	892.23	890.00	891.61	474001.	2406.	1866500.	21618100.	29056.	64.11	775.	0.	.6
PROJECT NO 2					YEAR OF STUDY 2009									
JAN	100.	571.	882.50	875.00	881.64	445001.	9024.	6922920.	20043300.	26940.	63.40	767.	0.	.8
FEB	94.	580.	867.50	860.00	866.58	418001.	8001.	6033600.	18265400.	27180.	62.32	754.	0.	.9
MAR	107.	464.	853.75	847.50	853.19	396001.	3278.	2433320.	18783000.	25246.	61.34	742.	0.	.5
APR	123.	442.	841.25	835.00	840.75	377001.	1659.	1213610.	18041100.	25057.	60.45	731.	0.	.4
MAY	418.	418.	835.00	835.00	834.51	377001.	1466.	1064060.	17591400.	23644.	59.98	725.	0.	.4
JUN	982.	595.	842.50	850.00	841.47	400001.	12512.	9160270.	16781000.	23307.	60.50	732.	0.	1.0
JUL	882.	372.	858.70	867.41	858.25	431340.	0.	0.	17096000.	22978.	61.71	746.	0.	.4
AUG	846.	374.	875.28	883.15	874.82	460309.	0.	0.	17546200.	23583.	62.91	761.	0.	.4
SEP	658.	401.	887.24	891.33	886.77	475555.	0.	0.	18446000.	25619.	63.76	771.	0.	.4
OCT	1018.	727.	893.16	895.00	891.13	484000.	19350.	15032800.	19705200.	26485.	64.13	776.	9388.	2.0
NOV	382.	454.	894.33	893.67	893.81	479676.	0.	0.	21032600.	29212.	64.24	777.	0.	.5
DEC	277.	454.	890.53	887.39	890.00	468790.	0.	0.	21618100.	29056.	63.99	774.	0.	.5
PROJECT NO 2					YEAR OF STUDY 2010									
JAN	53.	439.	881.19	875.00	880.70	445001.	887.	679544.	20043300.	26940.	63.31	766.	0.	.4
FEB	42.	528.	867.50	860.00	866.83	418001.	5116.	3858560.	18265400.	27180.	62.33	754.	0.	.6
MAR	66.	425.	853.75	847.50	853.26	396001.	872.	647099.	18783000.	25246.	61.33	742.	0.	.4
APR	114.	433.	841.25	835.00	840.75	377001.	1123.	821491.	18041100.	25057.	60.45	731.	0.	.4
MAY	507.	507.	835.00	835.00	834.36	377001.	6940.	5037500.	17591400.	23644.	59.98	725.	0.	.4
JUN	789.	402.	842.50	850.00	842.03	400001.	1044.	764870.	16781000.	23307.	60.54	732.	0.	.4
JUL	973.	387.	860.00	870.00	859.53	436001.	973.	727826.	17096000.	22978.	61.82	748.	0.	.4
AUG	768.	374.	876.55	883.10	876.09	460207.	0.	0.	17546200.	23583.	63.00	762.	0.	.4
SEP	930.	530.	889.05	895.00	888.57	484000.	7680.	5975480.	18446000.	25619.	63.98	774.	0.	.6
OCT	1284.	727.	895.00	895.00	892.97	484000.	19350.	15032800.	19705200.	26485.	64.21	777.	34244.	2.0
NOV	144.	456.	890.34	885.69	889.81	465398.	0.	0.	21032600.	29212.	63.97	774.	0.	.5
DEC	68.	459.	879.32	872.94	878.78	441302.	0.	0.	21618100.	29056.	63.18	764.	0.	.5
PROJECT NO 2					YEAR OF STUDY 2011									
JAN	39.	432.	866.22	859.49	865.72	417008.	0.	0.	20043300.	26940.	62.24	753.	0.	.4
FEB	44.	443.	853.15	846.81	852.65	394909.	0.	0.	18265400.	27180.	61.30	741.	0.	.4
MAR	53.	418.	839.48	832.15	839.00	372446.	0.	0.	18783000.	25246.	60.34	730.	0.	.4
APR	86.	422.	825.51	818.87	825.02	352418.	0.	0.	18041100.	25057.	59.29	717.	0.	.4
MAY	592.	400.	822.93	827.00	822.46	364213.	0.	0.	17591400.	23644.	59.08	714.	0.	.4
JUN	872.	387.	836.32	845.63	835.85	393017.	0.	0.	16781000.	23307.	60.08	726.	0.	.4
JUL	805.	374.	853.22	860.81	852.77	419474.	0.	0.	17096000.	22978.	61.32	742.	0.	.4
AUG	963.	376.	870.38	880.75	870.55	455518.	0.	0.	17546200.	23583.	62.59	757.	0.	.4
SEP	710.	402.	885.33	889.90	884.85	473809.	0.	0.	18446000.	25619.	63.63	769.	0.	.4
OCT	589.	423.	892.45	895.00	891.96	484000.	636.	494945.	19705200.	26485.	64.14	776.	0.	.4
NOV	357.	454.	894.10	893.21	893.58	478187.	0.	0.	21032600.	29212.	64.24	777.	0.	.5
DEC	89.	455.	887.01	880.81	886.48	455629.	0.	0.	21618100.	29056.	63.73	771.	0.	.5
PROJECT NO 2					YEAR OF STUDY 2012									
JAN	61.	428.	874.58	868.34	874.09	433022.	0.	0.	20043300.	26940.	62.84	760.	0.	.4
FEB	56.	438.	862.23	856.11	861.73	411009.	0.	0.	18917700.	27180.	61.95	749.	0.	.4
MAR	159.	412.	851.62	847.13	851.14	395414.	0.	0.	18783000.	25246.	61.18	740.	0.	.4
APR	177.	486.	841.06	835.00	840.45	377001.	4279.	3129500.	18041100.	25057.	60.44	731.	0.	.6
MAY	512.	511.	835.00	835.00	834.35	377001.	7247.	5260390.	17591400.	23644.	59.99	725.	0.	.6
JUN	864.	477.	842.50	850.00	841.90	400000.	5508.	4035580.	16781000.	23307.	60.55	732.	0.	.5
JUL	805.	372.	857.38	864.76	856.92	426569.	0.	0.	17096000.	22978.	61.62	745.	0.	.4
AUG	715.	376.	870.53	876.30	870.08	447355.	0.	0.	17546200.	23583.	62.56	757.	0.	.4
SEP	1133.	517.	885.65	895.00	884.99	484000.	6817.	5304090.	18446000.	25619.	63.78	771.	0.	.6
OCT	489.	488.	895.00	895.00	894.38	484000.	4739.	3687430.	19705200.	26485.	64.29	778.	0.	.6
NOV	340.	454.	893.85	892.71	893.33	477168.	0.	0.	21032600.	29212.	64.22	777.	0.	.5
DEC	125.	455.	887.06	881.41	886.53	456825.	0.	0.	21618100.	29056.	63.74	771.	0.	.5

LONG LAKE

MONTHLY REGULATION COMPUTATIONS
RULE CURVE OPERATION

	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT
PROJECT NO 2				YEAR OF S	
JAN	107.	427.	876.00	870.60	875.5
FEB	59.	437.	864.76	858.93	864.27
MAR	50.	412.	852.53	846.13	852.09
APR	64.	415.	839.28	832.44	838.80
MAY	570.	503.	833.72	835.00	833.00
JUN	949.	562.	842.50	850.00	841.71
JUL	905.	372.	859.10	868.20	858.69
AUG	799.	374.	875.31	882.42	876.09
SEP	1141.	718.	888.71	895.00	886.76
OCT	653.	652.	895.00	895.00	893.56
NOV	257.	455.	892.04	889.08	891.58
DEC	209.	456.	885.27	881.46	884.79
PROJECT NO 2				YEAR OF S	
JAN	88.	428.	875.73	870.00	875.20
FEB	44.	437.	863.93	857.05	863.45
MAR	56.	412.	851.49	845.12	851.01
APR	120.	415.	839.32	833.52	838.84
MAY	503.	464.	834.26	835.00	833.70
JUN	705.	385.	841.25	847.50	840.79
JUL	817.	373.	855.21	862.92	854.75
AUG	894.	376.	871.73	880.54	871.27
SEP	839.	401.	887.32	894.11	886.89
OCT	521.	473.	894.55	895.00	893.97
NOV	872.	727.	895.00	895.00	892.97
DEC	124.	454.	889.92	884.04	889.50
PROJECT NO 2				YEAR OF S	
JAN	31.	426.	878.39	871.89	877.88
FEB	28.	437.	865.54	859.23	865.09
MAR	39.	412.	852.64	846.05	852.16
APR	66.	415.	839.25	832.44	838.77
MAY	332.	395.	831.21	829.98	830.76
JUN	727.	387.	836.47	842.97	836.01
JUL	859.	375.	851.73	860.49	851.28
AUG	734.	378.	866.56	872.63	866.11
SEP	909.	404.	880.50	888.37	880.03
OCT	282.	415.	886.31	884.25	889.83
NOV	102.	462.	878.52	872.80	877.97
DEC	50.	467.	865.67	858.55	865.11
PROJECT NO 2				YEAR OF ST	
JAN	49.	440.	851.54	844.52	851.04
FEB	43.	451.	836.89	829.26	836.37
MAR	52.	428.	821.16	813.06	820.67
APR	101.	434.	805.40	797.74	804.91
MAY	412.	414.	797.70	797.65	797.22
JUN	868.	402.	808.25	818.86	807.78
JUL	954.	385.	830.27	841.69	829.81
AUG	637.	387.	846.59	851.50	846.13
SEP	699.	416.	856.17	860.84	855.69
OCT	293.	429.	858.51	856.18	858.02
NOV	122.	478.	849.85	843.52	849.25
DEC	86.	483.	835.65	827.78	835.04
PROJECT NO 2				YEAR OF STU	
JAN	36.	458.	818.34	808.90	817.88
FEB	36.	475.	799.48	790.07	798.90
MAR	47.	453.	780.07	770.08	779.55
APR	142.	461.	761.73	753.38	761.18
MAY	415.	442.	752.68	751.[illegible]	752.18
JUN	692.	432.	758.65	765.32	758.16
JUL	985.	413.	779.75	794.17	779.27
AUG	905.	408.	805.84	817.51	805.36
SEP	1042.	430.	829.44	841.37	828.95
OCT	1062.	432.	852.81	864.25	852.32
NOV	420.	470.	863.41	862.57	862.83
DEC	114.	472.	856.45	850.34	855.87
PROJECT NO 2				YEAR OF STU	
JAN	55.	444.	842.56	834.78	842.06
FEB	63.	457.	827.66	820.54	827.12
MAR	46.	433.	811.47	802.41	810.98
APR	80.	441.	794.05	785.69	793.55
MAY	540.	419.	788.60	791.50	788.11
JUN	891.	405.	802.70	813.89	802.22
JUL	877.	388.	824.05	834.20	823.58
AUG	961.	388.	845.13	856.07	844.67
SEP	832.	413.	863.00	869.92	862.52
OCT	858.	420.	877.16	884.39	876.67
NOV	135.	462.	879.22	874.06	878.67
DEC	131.	465.	868.34	862.62	867.78
PROJECT NO 2				YEAR OF STU	
JAN	67.	437.	856.29	849.95	855.79
FEB	260.	446.	846.60	843.26	846.10
MAR	56.	420.	836.06	828.85	835.57
APR	47.	425.	820.95	813.05	820.46
MAY	303.	407.	810.55	808.05	810.08
JUN	712.	398.	815.06	822.07	814.59
JUL	771.	385.	829.65	837.24	829.19
AUG	596.	389.	841.51	845.79	841.05
SEP	858.	417.	853.30	860.81	852.81
OCT	440.	428.	861.01	861.22	860.52
NOV	444.	472.	860.75	860.29	860.17
DEC	346.	471.	858.15	856.01	857.58
PROJECT NO 2				YEAR OF STU	
JAN	84.	441.	849.38	842.75	848.88
FEB	52.	452.	835.37	828.00	834.85
MAR	57.	429.	819.80	811.60	819.31
APR	63.	435.	803.19	794.79	802.70
MAY	270.	418.	791.10	787.41	790.61
JUN	633.	411.	792.57	797.72	792.09
JUL	978.	395.	811.23	824.74	810.76
AUG	1081.	391.	838.21	851.68	837.74
SEP	798.	415.	858.00	864.32	857.52
OCT	319.	427.	862.47	860.63	861.98
NOV	200.	475.	856.08	851.53	855.49
DEC	52.	479.	843.10	834.67	842.50
PROJECT NO 2				YEAR OF STU	
JAN	28.	454.	826.00	817.33	825.47
FEB	28.	469.	807.86	790.39	807.29
MAR	38.	447.	788.58	778.78	788.08
APR	66.	457.	768.66	758.54	768.12
MAY	462.	437.	759.17	759.79	758.67
JUN	558.	429.	763.26	766.74	762.77
JUL	964.	412.	780.58	794.42	780.10
AUG	1278.	404.	813.78	833.13	813.30
SEP	631.	426.	837.00	840.87	836.51
OCT	353.	439.	839.16	837.45	838.66
NOV	410.	486.	836.03	834.61	835.42
DEC	328.	486.	831.57	828.52	830.96
PROJECT NO 2				YEAR OF STU	
JAN	115.	437.	821.18	813.84	820.66
FEB	42.	471.	804.68	795.53	804.11
MAR	33.	449.	785.31	775.09	784.79
APR	82.	459.	765.31	755.53	764.77
MAY	446.	439.	755.69	755.85	755.20
JUN	756.	428.	764.38	772.92	763.89
JUL	784.	411.	782.04	791.16	781.56
AUG	762.	412.	799.47	807.78	798.99
SEP	967.	436.	819.03	830.29	818.54
OCT	554.	443.	832.43	834.56	831.93
NOV	424.	488.	833.37	832.18	832.75
DEC	112.	491.	824.37	816.56	823.75

(STO)RAGE (F)ROM AF	SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER K W	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
013								
000.	0.	0.	20043300.	26940.	62.94	761.	0.	.4
075.	0.	0.	18265400.	27180.	62.13	751.	0.	.4
011.	0.	0.	18783000.	25246.	61.26	741.	0.	.4
000.	0.	0.	18041100.	25057.	60.33	730.	0.	.4
001.	6681.	4841680.	17591400.	23644.	59.89	724.	0.	.6
001.	10566.	7741290.	16781000.	23307.	60.55	732.	0.	.7
765.	0.	0.	17096000.	22978.	61.74	747.	0.	.4
044.	0.	0.	17546200.	23583.	62.91	761.	0.	.4
000.	18830.	14629800.	18446000.	25619.	63.96	773.	0.	1.9
000.	14795.	11501400.	19705200.	26485.	64.23	777.	0.	1.4
162.	0.	0.	21032600.	29212.	64.06	775.	0.	.5
006.	0.	0.	21618100.	29056.	63.61	769.	0.	.5
014								
014.	0.	0.	20043300.	26940.	62.92	761.	0.	.4
142.	0.	0.	18265400.	27180.	62.07	751.	0.	.4
003.	0.	0.	18783000.	25246.	61.15	739.	0.	.4
535.	0.	0.	18041100.	25097.	60.34	730.	0.	.4
001.	4305.	3121910.	17591400.	23644.	59.93	725.	0.	.5
010.	0.	0.	16781000.	23307.	60.45	731.	0.	.4
250.	0.	0.	17096000.	22978.	61.46	743.	0.	.4
004.	0.	0.	17546200.	23583.	62.65	758.	0.	.4
105.	0.	0.	18446000.	25619.	63.77	771.	0.	.4
000.	3801.	2957670.	19705200.	26485.	64.27	777.	0.	.5
000.	16199.	12584800.	21032600.	29212.	64.21	777.	8624.	2.0
004.	0.	0.	21618100.	29056.	63.94	773.	0.	.5
2015								
949.	0.	0.	20043300.	26940.	63.11	763.	0.	.4
030.	0.	0.	18265400.	27180.	62.19	752.	0.	.4
093.	0.	0.	18783000.	25246.	61.27	741.	0.	.4
000.	0.	0.	18041100.	25057.	60.33	730.	0.	.4
079.	0.	0.	17591400.	23644.	59.72	722.	0.	.4
160.	0.	0.	16781000.	23307.	60.09	727.	0.	.4
096.	0.	0.	17096000.	22978.	61.21	740.	0.	.4
765.	0.	0.	17546200.	23583.	62.20	753.	0.	.4
747.	0.	0.	18446000.	25619.	63.28	765.	0.	.4
512.	0.	0.	19705200.	26485.	63.67	770.	0.	.4
065.	0.	0.	21032600.	29212.	63.12	763.	0.	.5
096.	0.	0.	21618100.	29056.	62.20	752.	0.	.5
016								
339.	0.	0.	20043300.	26940.	61.19	740.	0.	.4
019.	0.	0.	18917700.	27180.	60.14	727.	0.	.5
001.	0.	0.	18783000.	25246.	58.94	713.	0.	.4
047.	0.	0.	18041100.	25057.	57.69	698.	0.	.4
718.	0.	0.	17591400.	23644.	57.09	690.	0.	.4
000.	0.	0.	16781000.	23307.	57.88	700.	0.	.4
367.	0.	0.	17096000.	22978.	59.61	721.	0.	.4
699.	0.	0.	17546200.	23583.	60.83	736.	0.	.4
517.	0.	0.	18446000.	25619.	61.53	744.	0.	.4
137.	0.	0.	19705200.	26485.	61.69	746.	0.	.4
027.	0.	0.	21032600.	29212.	61.05	738.	0.	.5
442.	0.	0.	21618100.	29056.	60.04	726.	0.	.6
017								
467.	0.	0.	20043300.	26940.	58.72	710.	0.	.5
085.	0.	0.	18265400.	27180.	57.21	692.	0.	.5
100.	0.	0.	18783000.	25246.	55.68	673.	0.	.5
060.	0.	0.	18041100.	25057.	54.23	656.	0.	.5
390.	0.	0.	17591400.	23644.	53.47	647.	0.	.4
857.	0.	0.	16781000.	23307.	53.94	652.	0.	.4
010.	0.	0.	17096000.	22978.	55.60	672.	0.	.4
519.	0.	0.	17546200.	23583.	57.68	698.	0.	.4
023.	0.	0.	18446000.	25619.	59.55	720.	0.	.4
651.	0.	0.	19705200.	26485.	61.28	741.	0.	.4
030.	0.	0.	21032600.	29212.	62.06	751.	0.	.5
015.	0.	0.	21618100.	29056.	61.53	744.	0.	.5
2018								
048.	0.	0.	20043300.	26940.	60.56	732.	0.	.4
735.	0.	0.	18265400.	27180.	59.44	719.	0.	.5
902.	0.	0.	18783000.	25246.	58.17	703.	0.	.4
408.	0.	0.	18041100.	25057.	56.79	687.	0.	.4
005.	0.	0.	17591400.	23644.	56.33	681.	0.	.4
677.	0.	0.	16781000.	23307.	57.43	694.	0.	.4
722.	0.	0.	17096000.	22978.	59.16	715.	0.	.4
935.	0.	0.	17546200.	23583.	60.73	734.	0.	.4
064.	0.	0.	18446000.	25619.	62.02	750.	0.	.4
789.	0.	0.	19705200.	26485.	63.04	762.	0.	.4
300.	0.	0.	21032600.	29212.	63.17	764.	0.	.5
729.	0.	0.	21618100.	29056.	62.39	754.	0.	.5
019								
028.	0.	0.	20043300.	26940.	61.53	744.	0.	.4
567.	0.	0.	18265400.	27180.	60.86	736.	0.	.5
173.	0.	0.	18783000.	25246.	60.07	726.	0.	.4
048.	0.	0.	18041100.	25057.	58.92	713.	0.	.4
273.	0.	0.	17591400.	23644.	58.09	702.	0.	.4
098.	0.	0.	16781000.	23307.	58.41	706.	0.	.4
588.	0.	0.	17096000.	22978.	59.57	720.	0.	.4
266.	0.	0.	17546200.	23583.	60.50	732.	0.	.4
442.	0.	0.	18446000.	25619.	61.32	742.	0.	.4
197.	0.	0.	19705200.	26485.	61.97	748.	0.	.4
528.	0.	0.	21032600.	29212.	61.88	748.	0.	.5
033.	0.	0.	21618100.	29056.	61.67	746.	0.	.5
020								
054.	0.	0.	20043300.	26940.	61.02	738.	0.	.4
799.	0.	0.	18917700.	27180.	60.07	726.	0.	.5
922.	0.	0.	18783000.	25246.	58.83	711.	0.	.4
749.	0.	0.	18041100.	25057.	57.51	695.	0.	.4
041.	0.	0.	17591400.	23644.	56.54	684.	0.	.4
015.	0.	0.	16781000.	23307.	56.62	685.	0.	.4
038.	0.	0.	17096000.	22978.	58.11	703.	0.	.4
028.	0.	0.	17546200.	23583.	60.22	728.	0.	.4
790.	0.	0.	18446000.	25619.	61.66	746.	0.	.4
133.	0.	0.	19705200.	26485.	61.98	750.	0.	.4
765.	0.	0.	21032600.	29212.	61.48	744.	0.	.5
480.	0.	0.	21618100.	29056.	60.59	733.	0.	.5
021								
267.	0.	0.	20043300.	26940.	59.29	717.	0.	.5
745.	0.	0.	18265400.	27180.	57.88	700.	0.	.5
339.	0.	0.	18783000.	25246.	56.34	681.	0.	.5
254.	0.	0.	18041100.	25057.	54.78	662.	0.	.5
754.	0.	0.	17591400.	23644.	54.03	653.	0.	.4
614.	0.	0.	16781000.	23307.	54.29	656.	0.	.4
307.	0.	0.	17096000.	22978.	55.66	673.	0.	.4
322.	0.	0.	17546200.	23583.	58.31	705.	0.	.4
217.	0.	0.	18446000.	25619.	60.13	727.	0.	.4
020.	0.	0.	19705200.	26485.	60.32	729.	0.	.4
000.	0.	0.	21032600.	29212.	60.05	726.	0.	.6
042.	0.	0.	21618100.	29056.	59.74	722.	0.	.6
022								
010.	0.	0.	20043300.	26940.	58.94	713.	0.	.5
750.	0.	0.	18265400.	27180.	57.63	697.	0.	.5
111.	0.	0.	18783000.	25246.	56.10	678.	0.	.5
045.	0.	0.	18041100.	25057.	54.52	659.	0.	.5
322.	0.	0.	17591400.	23644.	53.75	650.	0.	.4
312.	0.	0.	16781000.	23307.	54.39	658.	0.	.4
196.	0.	0.	17096000.	22978.	55.79	675.	0.	.4
092.	0.	0.	17546200.	23583.	57.18	691.	0.	.4
677.	0.	0.	18446000.	25619.	58.73	710.	0.	.4
001.	0.	0.	19705200.	26485.	59.78	723.	0.	.4
000.	0.	0.	21032600.	29212.	59.05	724.	0.	.6
103.	0.	0.	21618100.	29056.	59.17	716.	0.	.6

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM, ALASKA

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

DESIGNED:
DRAWN: K.H.
CHECKED: LLL
PREPARED: LLL
SUPERVISED: M. D. Wade Jr. P.E.
APPROVED:
SUBMITTED:
RECOMMENDED:
SCALE NONE
DATE AUGUST 1968
FILE NUMBER Q-4-5-113
SHEET 2 OF 3

CORPS OF ENGINEERS

	FLOW		ELEVATION		HEAD	STORAGE	SECONDARY		PRIMARY			
				EOM		EOM		ENERGY		POWER		KWH/AF
	NATL CFS	REG CFS	AVERAGE FTMSL	FTMSL	AVERAGE FT	AF	SPILL AF	KWH	ENERGY KWH	K W	KW/CFS	
PROJECT NO 2				YEAR OF STUDY 2023								
JAN	182.	464.	809.87	803.19	809.32	331836.	0.	0.	20043300.	26940.	58.04	702.
FEB	66.	478.	794.26	785.32	793.66	308927.	0.	0.	18265400.	27180.	56.80	687.
MAR	47.	456.	774.81	764.30	774.28	283734.	0.	0.	18783000.	25246.	55.27	668.
APR	142.	465.	756.09	747.88	755.43	264456.	0.	0.	18041100.	25057.	53.77	650.
MAY	518.	464.	749.77	751.66	749.27	268999.	0.	0.	17591400.	23644.	53.23	644.
JUN	985.	427.	765.89	780.12	765.40	302164.	0.	0.	16781000.	23307.	54.50	659.
JUL	925.	405.	792.59	805.06	792.12	334090.	0.	0.	17096000.	22978.	56.62	685.
AUG	934.	402.	816.83	828.59	816.35	366751.	0.	0.	17546200.	23583.	58.56	708.
SEP	501.	429.	829.91	831.23	829.42	370982.	0.	0.	18446000.	25619.	59.59	721.
OCT	706.	440.	836.43	841.63	835.93	387289.	0.	0.	19705200.	26485.	60.08	727.
NOV	240.	485.	836.96	832.29	836.35	372673.	0.	0.	21032600.	29212.	60.19	727.
DEC	135.	490.	825.00	817.71	824.39	350806.	0.	0.	21618100.	29056.	59.22	716.
PROJECT NO 2				YEAR OF STUDY 2024								
JAN	66.	465.	808.24	798.76	807.68	326265.	0.	0.	20043300.	26940.	57.91	700.
FEB	66.	481.	789.51	780.27	788.91	302354.	0.	0.	18917700.	27180.	56.42	682.
MAR	57.	460.	769.53	758.80	768.99	277563.	0.	0.	18783000.	25246.	54.86	663.
APR	94.	470.	749.46	740.12	748.88	255147.	0.	0.	18041100.	25057.	53.23	644.
MAY	403.	451.	738.87	737.62	738.35	252147.	0.	0.	17591400.	23644.	52.33	633.
JUN	855.	439.	747.92	758.23	747.43	276880.	0.	0.	16781000.	23307.	53.04	641.
JUL	1143.	414.	776.85	795.47	776.37	321657.	0.	0.	17096000.	22978.	55.39	670.
AUG	845.	408.	805.76	816.05	805.28	348475.	0.	0.	17546200.	23583.	57.68	697.
SEP	551.	436.	818.49	820.93	817.99	355309.	0.	0.	18446000.	25619.	58.74	710.
OCT	535.	448.	822.83	824.74	822.32	360640.	0.	0.	19705200.	26485.	59.08	714.
NOV	259.	496.	819.66	814.58	819.03	346497.	0.	0.	21032600.	29212.	58.81	711.
DEC	190.	502.	807.03	799.48	806.39	327277.	0.	0.	21618100.	29056.	57.81	699.
PROJECT NO 2				YEAR OF STUDY 2025								
JAN	86.	476.	790.21	780.95	789.62	303230.	0.	0.	20043300.	26940.	56.48	683.
FEB	52.	494.	770.32	759.69	769.70	270638.	0.	0.	18265400.	27180.	54.91	664.
MAR	68.	474.	749.28	738.87	748.70	253491.	0.	0.	18783000.	25246.	53.21	643.
APR	139.	485.	729.90	720.93	729.29	233022.	0.	0.	18041100.	25057.	51.59	624.
MAY	446.	465.	720.37	719.81	719.81	231800.	0.	0.	17591400.	23644.	50.75	614.
JUN	666.	455.	725.46	731.10	724.93	244322.	0.	0.	16781000.	23307.	51.16	619.
JUL	986.	435.	745.21	759.33	744.72	278197.	0.	0.	17096000.	22978.	52.81	639.
AUG	919.	428.	772.10	784.87	771.61	308337.	0.	0.	17546200.	23583.	54.99	665.
SEP	925.	450.	795.85	806.84	795.34	336581.	0.	0.	18446000.	25619.	56.88	688.
OCT	773.	453.	814.20	821.57	813.68	356197.	0.	0.	19705200.	26485.	58.34	705.
NOV	317.	498.	817.62	813.68	817.00	345423.	0.	0.	21032600.	29212.	58.64	709.
DEC	276.	501.	808.31	802.95	807.68	331343.	0.	0.	21618100.	29056.	57.91	700.
PROJECT NO 2				YEAR OF STUDY 2026								
JAN	123.	474.	794.53	786.12	793.95	309956.	0.	0.	20043300.	26940.	56.82	687.
FEB	119.	489.	777.77	769.42	777.15	289364.	0.	0.	18265400.	27180.	55.49	671.
MAR	94.	466.	759.47	749.52	758.90	266430.	0.	0.	18783000.	25246.	54.06	654.
APR	191.	475.	742.46	735.39	741.87	249475.	0.	0.	18041100.	25057.	52.64	637.
MAY	479.	453.	736.04	736.69	735.51	251031.	0.	0.	17591400.	23644.	52.11	630.
JUN	960.	438.	749.74	762.80	749.25	282080.	0.	0.	16781000.	23307.	53.18	643.
JUL	1282.	410.	784.50	806.20	784.02	335679.	0.	0.	17096000.	22978.	56.00	677.
AUG	1400.	397.	827.26	848.33	826.79	397341.	0.	0.	17546200.	23583.	59.37	718.
SEP	679.	418.	852.74	857.15	852.25	412869.	0.	0.	18446000.	25619.	61.28	741.
OCT	906.	429.	865.35	873.55	864.86	442392.	0.	0.	19705200.	26485.	62.19	752.
NOV	194.	467.	869.02	864.49	868.45	426089.	0.	0.	21032600.	29212.	62.42	755.
DEC	53.	471.	857.34	850.19	856.76	400349.	0.	0.	21618100.	29056.	61.60	745.
PROJECT NO 2				YEAR OF STUDY 2027								
JAN	173.	443.	844.69	839.19	844.19	383708.	0.	0.	20043300.	26940.	60.73	734.
FEB	74.	454.	832.58	825.98	832.06	362576.	0.	0.	18265400.	27180.	59.80	723.
MAR	87.	430.	818.19	810.40	817.70	341486.	0.	0.	18783000.	25246.	58.71	710.
APR	80.	436.	802.40	794.41	801.91	320295.	0.	0.	18041100.	25057.	57.45	695.
MAY	288.	418.	791.16	787.92	790.68	312296.	0.	0.	17591400.	23644.	56.55	684.
JUN	753.	409.	795.93	803.94	795.45	332730.	0.	0.	16781000.	23307.	56.90	688.
JUL	851.	393.	814.41	824.89	813.95	360853.	0.	0.	17096000.	22978.	58.37	706.
AUG	787.	394.	832.44	839.99	831.97	384989.	0.	0.	17546200.	23583.	59.78	723.
SEP	1042.	418.	851.12	862.26	850.64	422069.	0.	0.	18446000.	25619.	61.16	740.
OCT	559.	426.	864.52	866.79	864.03	430228.	0.	0.	19705200.	26485.	62.13	751.
NOV	383.	469.	865.36	863.93	864.79	425073.	0.	0.	21032600.	29212.	62.19	752.
DEC	284.	469.	860.75	857.58	860.18	413647.	0.	0.	21618100.	29056.	61.84	748.
PROJECT NO 2				YEAR OF STUDY 2028								
JAN	137.	440.	852.23	846.88	851.73	395012.	0.	0.	20043300.	26940.	61.21	740.
FEB	203.	449.	842.14	837.41	841.63	380855.	0.	0.	18917700.	27180.	60.51	732.
MAR	103.	422.	831.26	825.11	830.77	361188.	0.	0.	18783000.	25246.	59.70	722.
APR	109.	426.	818.09	811.06	817.60	342275.	0.	0.	18041100.	25057.	58.70	710.
MAY	366.	407.	810.08	809.09	809.60	339736.	0.	0.	17591400.	23644.	58.05	702.
JUN	699.	398.	815.83	822.58	815.36	357613.	0.	0.	16781000.	23307.	58.47	707.
JUL	892.	384.	832.65	842.73	832.19	388833.	0.	0.	17096000.	22978.	59.80	723.
AUG	715.	386.	848.87	855.01	848.41	409026.	0.	0.	17546200.	23583.	61.00	738.
SEP	1168.	410.	867.52	880.03	867.04	454078.	0.	0.	18446000.	25619.	62.35	754.
OCT	527.	417.	881.71	883.39	881.23	460782.	0.	0.	19705200.	26485.	63.36	766.
NOV	128.	463.	878.04	872.69	877.49	440847.	0.	0.	21032600.	29212.	63.09	763.
DEC	93.	466.	866.30	859.92	865.74	417864.	0.	0.	21618100.	29056.	62.24	753.
PROJECT NO 2				YEAR OF STUDY 2029								
JAN	47.	439.	853.00	846.08	852.50	393730.	0.	0.	20043300.	26940.	61.29	741.
FEB	46.	450.	838.74	831.40	838.22	371248.	0.	0.	18265400.	27180.	60.29	729.
MAR	47.	427.	823.51	815.62	823.02	347880.	0.	0.	18783000.	25246.	59.11	715.
APR	122.	432.	808.39	801.16	807.90	329402.	0.	0.	18041100.	25057.	57.93	700.
MAY	239.	414.	797.08	793.00	796.60	318602.	0.	0.	17591400.	23644.	57.02	689.
JUN	816.	405.	802.33	811.66	801.86	343001.	0.	0.	16781000.	23307.	57.41	694.
JUL	807.	390.	820.71	829.76	820.25	368628.	0.	0.	17096000.	22978.	58.88	712.
AUG	1011.	389.	841.77	853.78	841.31	406820.	0.	0.	17546200.	23583.	60.49	731.
SEP	982.	412.	863.19	872.60	862.71	440681.	0.	0.	18446000.	25619.	62.04	750.
OCT	605.	420.	875.74	878.89	875.26	452005.	0.	0.	19705200.	26485.	62.93	761.
NOV	137.	465.	873.46	868.03	872.90	432462.	0.	0.	21032600.	29212.	62.76	759.
DEC	82.	469.	861.41	854.80	860.84	408639.	0.	0.	21618100.	29056.	61.89	748.
PROJECT NO 2				YEAR OF STUDY 2030								
JAN	83.	442.	847.95	841.11	847.45	386590.	0.	0.	20043300.	26940.	60.93	737.
FEB	123.	452.	835.31	829.52	834.79	368238.	0.	0.	18265400.	27180.	60.01	726.
MAR	49.	428.	821.39	815.27	820.90	344923.	0.	0.	18783000.	25246.	58.93	713.
APR	63.	434.	804.78	796.29	804.28	322806.	0.	0.	18041100.	25057.	57.64	697.
MAY	316.	416.	793.82	791.35	793.34	316623.	0.	0.	17591400.	23644.	56.76	686.
JUN	656.	409.	797.05	802.76	796.58	331317.	0.	0.	16781000.	23307.	56.97	689.
JUL	940.	393.	815.11	827.46	814.64	364935.	0.	0.	17096000.	22978.	58.43	707.
AUG	1218.	389.	843.14	858.83	842.68	415895.	0.	0.	17546200.	23583.	60.59	733.
SEP	872.	411.	866.44	874.05	865.96	443302.	0.	0.	18446000.	25619.	62.27	753.
OCT	652.	419.	877.92	881.79	877.43	457581.	0.	0.	19705200.	26485.	63.09	763.
NOV	623.	459.	884.22	886.64	883.68	467297.	0.	0.	21032600.	29212.	63.94	768.
DEC	89.	459.	880.69	874.74	880.15	444536.	0.	0.	21618100.	29056.	63.27	765.
PROJECT NO 2				YEAR OF STUDY 2031								
JAN	92.	431.	868.94	863.14	868.45	423665.	0.	0.	20043300.	26940.	62.44	755.
FEB	39.	441.	856.94	850.73	856.44	401317.	0.	0.	18265400.	27180.	61.57	745.
MAR	25.	416.	842.94	835.14	842.46	377236.	0.	0.	18783000.	25246.	60.59	733.
APR	67.	421.	828.34	821.54	827.86	356163.	0.	0.	18041100.	25057.	59.49	719.
MAY	283.	402.	818.92	816.30	818.45	348823.	0.	0.	17591400.	23644.	58.76	710.
JUN	703.	394.	822.58	828.05	822.11	367171.	0.	0.	16781000.	23307.	59.05	714.
JUL	1011.	380.	841.08	853.31	840.62	405959.	0.	0.	17096000.	22978.	60.44	731.
AUG	1152.	378.	866.52	879.72	866.06	453511.	0.	0.	17546200.	23583.	62.28	753.
SEP	1001.	488.	887.36	895.00	886.74	484000.	5177.	4028260.	18446000.	25619.	63.88	772.
OCT	504.	503.	895.00	895.00	894.36	484000.	5661.	4404740.	19705200.	26485.	64.29	778.
NOV	323.	455.	893.41	891.83	892.88	476144.	0.	0.	21032600.	29212.	64.19	776.
DEC	171.	455.	887.07	882.31	886.54	458630.	0.	0.	21618100.	29056.	63.74	771.
PROJECT NO 2				YEAR OF STUDY 2032								
JAN	197.	426.	878.51	874.71	878.02	444493.	0.	0.	20043300.	26940.	63.10	763.
FEB	52.	512.	867.36	860.00	866.71	418001.	4398.	3316470.	18917700.	27180.	62.32	754.
MAR	47.	411.	853.62	847.24	853.14	395585.	0.	0.	18783000.	25246.	61.34	742.
APR	118.	430.	841.12	835.00	840.63	377001.	941.	688253.	18041100.	25057.	60.44	731.
MAY	292.	395.	833.02	831.04	832.55	370667.	0.	0.	17591400.	23644.	59.85	724.
JUN	515.	389.	833.37	835.71	832.91	378143.	0.	0.	16781000.	23307.	59.86	724.
JUL	816.	378.	844.25	852.79	843.79	405029.	0.	0.	17096000.	22978.	60.67	734.
AUG	992.	380.	863.24	873.69	862.78	442653.	0.	0.	17546200.	23583.	62.04	750.
SEP	944.	404.	882.18	890.67	881.70	474782.	0.	0.	17546200.	23583.	62.04	750.
OCT	526.	412.	892.48	894.30	892.00	481734.	0.	0.	18446000.	25619.	63.40	767.
NOV	181.	456.	889.98	885.66	889.44	465324.	0.	0.	19705200.	26485.	64.14	776.
DEC	121.	459.	880.19	874.73	879.65	444515.	0.	0.	21032600.	29212.	63.94	773.

LONG LAKE

MONTHLY REGULATION COMPUTATIONS

RULE CURVE OPERATION

ASTE AF	TAIL WATER
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NOTES:

1. STORAGE EOM EQUALS THE STORAGE IN THE RESERVOIR AT THE END OF THE MONTH.
2. WASTE IS THE NONUSABLE OUTFLOW WASTED OVER THE SPILLWAY.
3. YEARS ARE PROJECTED INTO THE ASSUMED TIME OF PROJECT OPERATION WITH 1983 EQUIVALENT TO THE FIRST YEAR OF PERIOD OF RECORD.
4. LONG LAKE PRODUCES 225 MILLION KWH/YEAR PRIMARY ENERGY AND 10.8 MILLION KWH/YEAR OF SECONDARY ENERGY WITH BENEFIT OF RULE CURVE OPERATION. SEE PLATES 2 & 3 AND TABLES 7 & 10.

U. S. ARMY

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:	SNETTISHAM, ALASKA
DRAWN: T.S.	LONG LAKE
CHECKED: LTF	
PREPARED: FFF	MONTHLY REGULATION COMPUTATIONS
SUPERVISED: W D Wade Jr, P.E. CHIEF, FIELD INVESTIGATIONS SECTION	APPROVED: [signature] Lt Col, CE COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: [signature] CHIEF, PLANNING AND REPORTS	SCALE NONE — DATE AUGUST 1966
RECOMMENDED: [signature] CHIEF, ENGINEERING DIVISION	FILE NUMBER Q-4-5-113 — SHEET 3 OF 3

	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT	STORAGE EOM AF	SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
PROJECT NO 4				YEAR OF STUDY 1980										
JAN	35.	187.	961.48	955.37	961.[illegible]	75237.	0.	0.	9444700.	12694.	67.58	817.	0.	.4
FEB	47.	195.	914.92	904.[illegible]	914.43	65698.	0.	0.	8914290.	12807.	65.52	792.	0.	.4
MAR	46.	186.	883.6[illegible]	872.76	883.12	58186.	0.	0.	8850840.	11896.	63.80	772.	0.	.4
APR	57.	190.	871.31	860.86	871.43	53259.	0.	0.	8501250.	11807.	62.07	751.	0.	.4
MAY	203.	181.	863.05	865.14	862.53	51577.	0.	0.	8289350.	11141.	61.33	742.	0.	.4
JUN	531.	172.	892.5[illegible]	919.76	892.[illegible]	7[illegible]936.	0.	0.	7907470.	10962.	63.68	770.	0.	.4
JUL	830.	34[illegible].	957.77	985.31	956.47	102907.	1128[illegible].	9316440.	8055950.	10827.	68.25	825.	0.	2.3
AUG	858.	426.	1003.9[illegible]	1022.[illegible]	1001.49	121000.	10758.	9104320.	8268070.	11113.	72.75	880.	14928.	1.9
SEP	491.	318.	1022.00	1022.00	1020.15	121000.	9147.	8119940.	8692050.	12072.	73.35	887.	10275.	1.8
OCT	260.	259.	1022.00	1022.00	1021.14	121000.	5531.	4915390.	9285410.	12480.	73.41	888.	0.	.8
NOV	106.	188.	1017.22	1012.45	1016.75	115223.	0.	0.	9910870.	13765.	73.10	884.	0.	.4
DEC	34.	187.	1003.12	993.77	1002.64	106895.	0.	0.	10186800.	13692.	72.17	873.	0.	.4
PROJECT NO 4				YEAR OF STUDY 1981										
JAN	21.	179.	984.05	974.31	983.58	97157.	0.	0.	9444700.	12694.	70.76	856.	0.	.4
FEB	45.	184.	965.56	956.81	965.08	89406.	0.	0.	8606900.	12807.	69.39	839.	0.	.4
MAR	37.	174.	947.13	937.85	946.87	80928.	0.	0.	8850840.	11896.	68.02	823.	0.	.4
APR	53.	186.	928.72	920.03	928.44	73000.	535.	431966.	8501250.	11807.	66.61	806.	0.	.4
MAY	144.	167.	918.65	916.16	917.63	71441.	0.	0.	8289350.	11141.	65.79	796.	0.	.4
JUN	272.	[illegible]	923.38	931.51	923.36	77757.	0.	0.	7907470.	10982.	66.21	801.	0.	.4
JUL	517.	157.	955.4[illegible]	979.07	955.16	97845.	0.	0.	8055950.	10827.	68.63	830.	0.	.4
AUG	409.	155.	995.30	1010.91	994.87	113452.	0.	0.	8268070.	11113.	71.61	866.	0.	.4
SEP	266.	172.	1016.45	1022.00	1016.00	121000.	445.	395488.	8692050.	12072.	73.06	884.	0.	.4
OCT	313.	312.	1022.00	1022.00	1020.25	121000.	8784.	7796070.	9285410.	12480.	73.35	887.	0.	1.7
NOV	164.	188.	1016.98	1011.97	1016.51	117983.	0.	0.	9910870.	13765.	73.09	884.	0.	.4
DEC	24.	189.	1001.77	991.97	1001.29	107781.	0.	0.	10186800.	13692.	72.08	872.	0.	.4
PROJECT NO 4				YEAR OF STUDY 1982										
JAN	36.	179.	982.73	971.89	982.26	96948.	0.	0.	9444700.	12694.	70.65	854.	0.	.4
FEB	17.	184.	963.56	953.29	963.09	87621.	0.	0.	8606900.	12807.	69.25	837.	0.	.4
MAR	45.	172.	944.21	935.17	943.75	79597.	0.	0.	8850840.	11896.	67.78	820.	0.	.4
APR	74.	184.	927.59	920.0[illegible]	927.12	73000.	438.	352751.	8501250.	11807.	66.51	804.	0.	.4
MAY	235.	134.	920.00	920.00	919.35	73000.	4056.	3235590.	8289350.	11141.	65.91	797.	0.	.6
JUN	414.	262.	930.00	940.00	929.58	82000.	5829.	4701600.	7907470.	10982.	66.65	806.	0.	.9
JUL	497.	204.	960.00	980.00	959.48	100001.	2905.	2425140.	8055950.	10827.	68.97	834.	0.	.5
AUG	469.	194.	997.52	1015.01	997.03	117501.	1818.	1578860.	8268070.	11113.	71.77	868.	0.	.4
SEP	389.	318.	1018.55	1022.00	1016.65	121000.	9149.	8119940.	8692050.	12072.	73.21	885.	469.	1.8
OCT	185.	184.	1022.00	1022.00	1021.53	121000.	931.	827394.	9285410.	12480.	73.47	889.	0.	.4
NOV	45.	188.	1013.43	1004.87	1012.95	112433.	0.	0.	9910870.	13765.	72.83	881.	0.	.4
DEC	33.	191.	995.14	985.41	994.65	102708.	0.	0.	10186800.	13692.	71.62	866.	0.	.4
PROJECT NO 4				YEAR OF STUDY 1983										
JAN	16.	181.	974.80	964.18	974.33	92675.	0.	0.	9444700.	12694.	70.06	847.	0.	.4
FEB	18.	186.	953.71	943.23	953.23	83293.	0.	0.	8606900.	12807.	68.51	829.	0.	.4
MAR	19.	177.	932.27	921.31	931.80	73523.	0.	0.	8850840.	11896.	66.87	809.	0.	.4
APR	44.	181.	911.11	900.92	910.64	65369.	0.	0.	8501250.	11807.	65.21	789.	0.	.4
MAY	90.	174.	894.43	887.94	893.97	60177.	0.	0.	8289350.	11141.	63.87	772.	0.	.4
JUN	370.	173.	902.80	917.66	902.35	72066.	0.	0.	7907470.	10982.	64.52	780.	0.	.4
JUL	320.	161.	932.40	947.19	931.96	84859.	0.	0.	8055950.	10827.	66.86	809.	0.	.4
AUG	464.	159.	967.13	987.11	966.69	103556.	0.	0.	8268070.	11113.	69.48	840.	0.	.4
SEP	470.	176.	1004.55	1022.00	1004.07	121000.	579.	514575.	8692050.	12072.	72.30	874.	0.	.4
OCT	270.	269.	1022.00	1022.00	1020.97	121000.	6147.	5459940.	9285410.	12480.	73.40	888.	0.	1.0
NOV	51.	188.	1013.79	1005.57	1013.31	112794.	0.	0.	9910870.	13765.	72.86	881.	0.	.4
DEC	33.	191.	995.87	986.15	995.38	103078.	0.	0.	10186800.	13692.	71.67	867.	0.	.4
PROJECT NO 4				YEAR OF STUDY 1984										
JAN	35.	183.	976.97	967.18	976.50	94115.	0.	0.	9444700.	12694.	70.21	849.	0.	.4
FEB	45.	183.	958.90	950.02	958.43	86012.	0.	0.	8914290.	12807.	68.91	833.	0.	.4
MAR	23.	176.	939.40	928.94	939.02	76578.	0.	0.	8850840.	11896.	67.42	815.	0.	.4
APR	24.	179.	917.37	905.79	916.90	67317.	0.	0.	8501250.	11807.	65.72	795.	0.	.4
MAY	142.	172.	903.45	901.11	903.00	65446.	0.	0.	8289350.	11141.	64.61	781.	0.	.4
JUN	305.	168.	911.27	921.43	910.82	73574.	0.	0.	7907470.	10982.	65.21	789.	0.	.4
JUL	441.	160.	940.54	959.65	940.10	90824.	0.	0.	8055950.	10827.	67.40	816.	0.	.4
AUG	539.	157.	984.13	1008.62	983.70	114337.	0.	0.	8268070.	11113.	70.74	855.	0.	.4
SEP	361.	248.	1015.31	1022.00	1014.82	121000.	4940.	4389330.	8692050.	12072.	73.10	884.	0.	.7
OCT	251.	250.	1022.00	1022.00	1021.29	121000.	4981.	4425650.	9285410.	12480.	73.42	888.	0.	.6
NOV	250.	249.	1022.00	1022.00	1021.31	121000.	3720.	3305320.	9910870.	13765.	73.42	888.	0.	.6
DEC	35.	213.	1011.00	1000.01	1010.44	110001.	1566.	1376770.	10186800.	13692.	72.65	879.	0.	.5
PROJECT NO 4				YEAR OF STUDY 1985										
JAN	33.	195.	990.00	980.00	989.51	100001.	1075.	926756.	9444700.	12694.	71.24	862.	0.	.4
FEB	17.	183.	969.74	959.48	969.26	90740.	0.	0.	8606900.	12807.	69.69	843.	0.	.4
MAR	13.	174.	948.54	937.60	948.08	80801.	0.	0.	8850840.	11896.	68.12	824.	0.	.4
APR	21.	177.	926.90	916.20	926.43	71480.	0.	0.	8501250.	11807.	66.58	805.	0.	.4
MAY	129.	173.	914.02	909.84	913.57	68937.	0.	0.	8289350.	11141.	65.39	791.	0.	.4
JUN	347.	166.	922.62	935.40	922.17	79701.	0.	0.	7907470.	10982.	66.11	800.	0.	.4
JUL	482.	157.	957.35	979.31	956.92	98656.	0.	0.	8055950.	10827.	68.76	832.	0.	.4
AUG	591.	243.	1000.65	1022.00	999.98	121000.	5533.	4889640.	8268070.	11113.	72.51	877.	0.	.6
SEP	411.	318.	1022.00	1022.00	1020.15	121000.	9149.	8119940.	8692050.	12072.	73.23	887.	5515.	1.8
OCT	202.	201.	1022.00	1022.00	1021.51	121000.	1970.	1750720.	9285410.	12480.	73.43	888.	0.	.4
NOV	133.	191.	1018.50	1015.01	1018.02	117501.	229.	202897.	9910870.	13765.	73.22	886.	0.	.4
DEC	65.	189.	1007.38	999.75	1006.90	109875.	0.	0.	10186800.	13692.	72.43	876.	0.	.4
PROJECT NO 4				YEAR OF STUDY 1986										
JAN	68.	228.	989.87	980.00	989.24	100001.	3098.	2669990.	9444700.	12694.	71.22	861.	0.	.4
FEB	15.	183.	969.62	959.25	969.15	90628.	0.	0.	8606900.	12807.	69.69	843.	0.	.4
MAR	12.	174.	948.25	937.25	947.79	80624.	0.	0.	8850840.	11896.	68.09	823.	0.	.4
APR	47.	177.	928.46	919.67	927.99	72869.	0.	0.	8501250.	11807.	66.58	805.	0.	.4
MAY	118.	169.	915.68	911.19	915.23	69679.	0.	0.	8289350.	11141.	65.54	793.	0.	.4
JUN	217.	167.	915.77	919.34	914.92	72618.	0.	0.	7907470.	10982.	65.52	792.	0.	.4
JUL	517.	161.	936.87	953.70	936.43	88351.	0.	0.	8055950.	10827.	67.20	813.	0.	.4
AUG	511.	158.	977.39	1000.69	976.96	110041.	0.	0.	8268070.	11113.	70.22	849.	0.	.4
SEP	420.	235.	1011.44	1022.00	1010.37	121000.	4143.	3681320.	8692050.	12072.	72.87	881.	0.	.4
OCT	209.	208.	1022.00	1022.00	1021.47	121000.	2401.	2133680.	9285410.	12480.	73.43	888.	0.	.4
NOV	67.	188.	1014.76	1007.52	1014.29	113757.	0.	0.	9910870.	13765.	72.93	882.	0.	.4
DEC	45.	190.	998.57	989.62	998.08	104811.	0.	0.	10186800.	13692.	71.87	869.	0.	.4
PROJECT NO 4				YEAR OF STUDY 1987										
JAN	100.	179.	984.74	979.87	984.28	99938.	5.	4310.	9444700.	12694.	70.84	857.	0.	.4
FEB	35.	195.	969.93	960.00	969.44	91000.	678.	571973.	8606900.	12807.	69.71	843.	0.	.4
MAR	16.	175.	949.25	938.53	948.79	81254.	0.	0.	8850840.	11896.	68.17	824.	0.	.4
APR	70.	177.	927.86	917.71	927.39	71855.	0.	0.	8501250.	11807.	66.53	805.	0.	.4
MAY	53.	171.	908.10	899.00	907.65	64601.	0.	0.	8289350.	11141.	64.97	786.	0.	.4
JUN	177.	170.	899.45	899.91	899.00	64965.	0.	0.	7907470.	10982.	64.27	777.	0.	.4
JUL	406.	169.	917.75	935.60	917.31	79800.	0.	0.	8055950.	10827.	65.72	795.	0.	.4
AUG	532.	161.	960.40	985.21	959.96	102608.	0.	0.	8268070.	11113.	68.99	834.	0.	.4
SEP	262.	174.	992.73	998.25	990.29	108122.	0.	0.	8692050.	12072.	71.79	868.	0.	.4
OCT	140.	174.	994.11	990.02	993.67	106008.	0.	0.	9285410.	12480.	71.56	865.	0.	.4
NOV	92.	194.	985.94	979.86	985.45	99933.	0.	0.	9910870.	13765.	70.91	858.	0.	.4
DEC	29.	196.	968.30	956.74	967.81	89373.	0.	0.	10186800.	13692.	69.59	842.	0.	.4
PROJECT NO 4				YEAR OF STUDY 1988										
JAN	24.	186.	945.72	934.70	945.24	79354.	0.	0.	9444700.	12694.	67.90	821.	0.	.4
FEB	31.	193.	923.61	912.52	923.12	70011.	0.	0.	8914290.	12807.	66.21	801.	0.	.4
MAR	24.	184.	900.16	887.79	899.68	60117.	0.	0.	8850840.	11896.	64.33	778.	0.	.4
APR	34.	189.	875.35	862.90	874.87	50872.	0.	0.	8501250.	11807.	62.34	754.	0.	.4
MAY	138.	182.	858.12	853.74	857.85	48121.	0.	0.	8289350.	11141.	60.97	737.	0.	.4
JUN	305.	176.	865.17	876.61	864.71	55646.	0.	0.	7907470.	10982.	61.55	744.	0.	.4
JUL	399.	169.	894.24	911.87	893.79	69749.	0.	0.	8055950.	10827.	63.83	772.	0.	.4
AUG	360.	167.	925.52	939.17	925.07	81584.	0.	0.	8268070.	11113.	66.33	802.	0.	.4
SEP	297.	177.	947.27	955.38	946.81	88694.	0.	0.	8692050.	12072.	68.00	822.	0.	.4
OCT	290.	180.	963.13	970.87	962.66	95437.	0.	0.	9285410.	12480.	69.20	837.	0.	.4
NOV	75.	198.	962.52	954.12	962.00	88060.	0.	0.	9910870.	13765.	69.17	837.	0.	.4
DEC	95.	201.	946.97	939.32	946.57	81514.	0.	0.	10186800.	13692.	67.96	822.	0.	.4
PROJECT NO 4				YEAR OF STUDY 1989										
JAN	34.	197.	928.11	917.19	927.62	71877.	0.	0.	9444700.	12694.	66.55	805.	0.	.4
FEB	10.	194.	904.13	891.08	903.64	61431.	0.	0.	8606900.	12807.	64.65	782.	0.	.4
MAR	10.	194.	876.08	861.08	875.59	51326.	0.	0.	8850840.	11896.	62.41	755.	0.	.4
APR	35.	196.	846.31	832.35	846.21	40701.	0.	0.	8501250.	11807.	60.01	726.	0.	.4
MAY	145.	190.	827.66	822.99	827.18	37899.	0.	0.	8289350.	11141.	58.46	707.	0.	.4
JUN	287.	186.	837.98	842.17	832.10	43870.	0.	0.	7907470.	10982.	58.83	711.	0.	.4
JUL	437.	176.	864.72	887.27	864.26	59908.	0.	0.	8055950.	10827.	61.46	743.	0.	.4
AUG	471.	173.	910.00	932.74	909.55	78171.	0.	0.	8268070.	11113.	65.09	787.	0.	.4
SEP	352.	178.	944.68	955.43	943.62	88715.	0.	0.	8692050.	12072.	67.75	819.	0.	.4
OCT	202.	181.	956.68	957.94	956.21	89970.	0.	0.	9285410.	12480.	68.72	831.	0.	.4
NOV	158.	203.	955.41	952.88	954.91	87442.	0.	0.	9910870.	13765.	68.65	830.	0.	.4
DEC	41.	202.	941.95	931.52	941.45	77512.	0.	0.	10186800.	13692.	67.61	818.	0.	.5

	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT	STORAGE EOM AF	SECONDARY SPILL AF
PROJECT NO 4				YEAR OF STUDY 1990			
JAN	21.	193.	917.93	904.54	917.44	60936.	0.
FEB	26.	20[illegible].	892.03	880.61	[illegible]92.33	57437.	0.
MAR	38.	192.	866.7[illegible]	852.09	865.21	47837.	0.
APR	47.	190.	839.36	825.44	838.63	38774.	0.
MAY	160.	191.	822.60	819.45	822.17	36621.	0.
JUN	297.	187.	830.14	840.17	829.65	43359.	0.
JUL	452.	175.	864.57	888.27	864.11	62307.	0.
AUG	483.	176.	911.60	935.10	911.21	79331.	0.
SEP	502.	175.	956.47	977.69	956.21	95985.	0.
OCT	230.	177.	981.14	984.40	980.68	102201.	0.
NOV	198.	194.	984.61	984.83	984.12	102417.	0.
DEC	77.	194.	977.58	970.36	977.09	95170.	0.
PROJECT NO 4				YEAR OF STUDY 1991			
JAN	26.	184.	959.63	948.93	959.16	85574.	0.
FEB	17.	190.	938.16	927.18	937.67	75953.	0.
MAR	30.	184.	915.75	904.11	915.20	66046.	0.
APR	39.	185.	893.24	882.18	892.77	57951.	0.
MAY	229.	176.	886.42	890.47	885.76	61190.	0.
JUN	400.	167.	907.64	924.81	907.19	74926.	0.
JUL	584.	176.	952.40	980.00	951.94	100001.	1096.
AUG	566.	224.	1001.00	1022.00	1000.37	121000.	4314.
SEP	581.	316.	1022.00	1022.00	1020.15	121000.	9149.
OCT	197.	190.	1022.00	1022.00	1021.51	121000.	1663.
NOV	124.	188.	1018.19	1014.39	1017.72	117191.	0.
DEC	95.	211.	1007.20	1000.01	1006.65	110001.	1407.
PROJECT NO 4				YEAR OF STUDY 1992			
JAN	35.	197.	990.00	980.00	989.51	100001.	1198.
FEB	27.	183.	969.98	959.97	969.51	90987.	99.
MAR	23.	175.	949.78	939.61	949.32	81801.	0.
APR	38.	185.	929.80	920.00	929.37	73000.	526.
MAY	161.	169.	919.37	918.75	918.92	72502.	0.
JUN	350.	190.	929.37	940.00	928.89	82000.	1521.
JUL	377.	157.	955.47	970.79	955.04	95479.	0.
AUG	357.	157.	983.24	995.55	982.80	107763.	0.
SEP	352.	230.	1002.77	1010.01	1002.14	115001.	3749.
OCT	135.	172.	1007.72	1005.43	1007.27	112713.	0.
NOV	48.	191.	996.80	988.30	996.38	104154.	0.
DEC	25.	194.	977.54	966.77	977.05	93709.	0.
PROJECT NO 4				YEAR OF STUDY 1993			
JAN	89.	183.	960.25	953.74	959.78	87871.	0.
FEB	31.	188.	943.96	934.19	943.48	79096.	0.
MAR	40.	179.	923.99	913.78	923.52	70514.	0.
APR	42.	182.	903.31	892.04	902.84	62136.	0.
MAY	193.	174.	894.26	895.68	893.80	63272.	0.
JUN	381.	168.	911.49	927.31	911.04	75924.	0.
JUL	528.	158.	952.30	977.30	951.87	98653.	0.
AUG	377.	155.	990.90	1004.55	990.47	112290.	0.
SEP	363.	195.	1013.25	1022.00	1012.76	121000.	1793.
OCT	194.	193.	1022.00	1022.00	1021.52	121000.	1479.
NOV	113.	188.	1017.52	1013.25	1017.05	116524.	0.
DEC	82.	189.	1006.46	999.87	1005.98	109934.	0.
PROJECT NO 4				YEAR OF STUDY 1994			
JAN	76.	237.	989.93	980.00	989.27	100001.	3649.
FEB	19.	183.	969.85	959.70	969.37	90852.	0.
MAR	49.	192.	949.85	940.00	949.36	82000.	1142.
APR	29.	180.	930.00	920.00	929.53	73000.	192.
MAY	92.	170.	913.98	907.97	913.53	68189.	0.
JUN	382.	166.	923.02	938.08	922.58	81040.	0.
JUL	419.	157.	956.15	974.21	955.71	97109.	0.
AUG	404.	156.	989.46	1004.71	989.03	112351.	0.
SEP	347.	201.	1013.35	1022.00	1012.86	121000.	2133.
OCT	463.	318.	1022.00	1022.00	1020.15	121000.	9111.
NOV	222.	221.	1022.00	1022.00	1021.40	121000.	2055.
DEC	60.	238.	1011.00	1000.01	1010.34	110001.	3102.
PROJECT NO 4				YEAR OF STUDY 1995			
JAN	5.	178.	989.35	978.69	988.88	99346.	0.
FEB	9.	184.	967.96	957.24	967.49	89621.	0.
MAR	15.	175.	946.42	935.36	945.95	79780.	0.
APR	34.	177.	925.55	915.54	925.08	71216.	0.
MAY	104.	170.	910.39	905.24	909.93	67097.	0.
JUN	308.	167.	915.69	926.14	915.24	75457.	0.
JUL	420.	159.	943.63	961.12	943.19	91451.	0.
AUG	484.	157.	982.09	1003.06	981.65	111529.	0.
SEP	359.	199.	1012.53	1022.00	1012.04	121000.	2017.
OCT	225.	224.	1022.00	1022.00	1021.39	121000.	3384.
NOV	256.	255.	1022.00	1022.00	1021.21	121000.	4076.
DEC	146.	321.	1011.20	1000.40	1009.28	110198.	8181.
PROJECT NO 4				YEAR OF STUDY 1996			
JAN	68.	233.	990.20	980.00	989.55	100001.	3425.
FEB	102.	258.	970.00	960.00	969.15	91000.	4297.
MAR	22.	174.	949.62	939.25	949.16	81628.	0.
APR	45.	190.	929.62	920.00	929.14	73000.	767.
MAY	211.	211.	920.00	920.00	919.45	73000.	2582.
JUN	402.	250.	930.00	940.00	929.28	82000.	5118.
JUL	417.	157.	957.96	975.93	957.50	97966.	0.
AUG	474.	156.	995.47	1015.01	995.04	117501.	71.
SEP	361.	302.	1018.50	1022.00	1016.94	121000.	8155.
OCT	334.	318.	1022.00	1022.00	1020.15	121000.	9111.
NOV	73.	188.	1015.12	1008.24	1014.65	114118.	0.
DEC	28.	190.	998.24	988.25	997.75	104122.	0.
PROJECT NO 4				YEAR OF STUDY 1997			
JAN	20.	180.	978.18	968.12	977.71	94250.	0.
FEB	20.	186.	957.84	947.56	957.37	85026.	0.
MAR	15.	177.	936.36	925.15	935.89	75062.	0.
APR	33.	180.	914.19	903.23	913.72	66294.	0.
MAY	105.	173.	897.95	892.68	897.49	62072.	0.
JUN	284.	170.	901.12	909.55	900.66	68823.	0.
JUL	362.	163.	923.80	938.05	923.36	81025.	0.
AUG	366.	162.	952.19	966.34	951.75	93537.	0.
SEP	429.	171.	982.00	997.78	981.60	108886.	0.
OCT	316.	172.	1006.60	1015.43	1006.15	117713.	0.
NOV	42.	190.	1006.61	997.80	1006.13	108897.	0.
DEC	27.	192.	987.63	977.41	987.12	98709.	0.
PROJECT NO 4				YEAR OF STUDY 1998			
JAN	14.	182.	966.03	954.65	965.56	88328.	0.
FEB	13.	189.	943.88	933.10	943.40	78553.	0.
MAR	15.	180.	920.79	908.48	920.32	68392.	0.
APR	66.	183.	899.73	890.98	899.25	61393.	0.
MAY	211.	174.	893.77	896.57	893.31	63628.	0.
JUN	230.	170.	900.96	905.40	900.53	67159.	0.
JUL	379.	164.	921.07	936.75	920.63	80375.	0.
AUG	367.	162.	950.79	964.83	950.35	92932.	0.
SEP	252.	173.	970.03	975.24	969.57	97622.	0.
OCT	219.	177.	977.78	980.33	977.32	100165.	0.
NOV	170.	195.	978.80	977.27	978.31	98639.	0.
DEC	43.	197.	966.80	956.33	966.31	89167.	0.
PROJECT NO 4				YEAR OF STUDY 1999			
JAN	7.	187.	944.25	932.16	943.77	78084.	0.
FEB	12.	194.	919.78	907.40	919.29	67960.	0.
MAR	18.	186.	894.47	881.54	893.99	57616.	0.
APR	31.	191.	867.56	853.59	867.08	48079.	0.
MAY	100.	185.	846.47	839.35	846.00	42806.	0.
JUN	371.	180.	856.08	872.81	855.61	54127.	0.
JUL	420.	170.	892.02	911.23	891.56	69492.	0.
AUG	565.	164.	939.48	967.73	939.03	94093.	0.
SEP	342.	171.	978.08	988.44	977.63	104222.	0.
OCT	269.	174.	994.26	1000.08	993.80	110036.	0.
NOV	92.	192.	994.10	988.12	993.61	104063.	0.
DEC	67.	194.	980.29	972.46	979.80	96234.	0.

CRATER LAKE

MONTHLY REGULATION COMPUTATIONS

W/RULE CURVE OPERATION

U. S. ARMY

SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
0.	9444700.	12694.	65.77	795.	0.	.4
0.	8606900.	12807.	63.74	771.	0.	.4
0.	8850840.	11896.	61.66	746.	0.	.4
0.	8501250.	11807.	59.39	718.	0.	.4
0.	8289350.	11141.	58.09	702.	0.	.4
0.	7907470.	10982.	58.64	709.	0.	.4
0.	8055950.	10827.	61.44	743.	0.	.4
0.	8268070.	11113.	65.23	789.	0.	.4
0.	8692050.	12072.	68.69	831.	0.	.4
0.	9285410.	12480.	70.49	852.	0.	.4
0.	9910870.	13765.	70.82	856.	0.	.4
0.	10186800.	13692.	70.26	850.	0.	.4
0.	9444700.	12694.	68.97	834.	0.	.4
0.	8606900.	12807.	67.32	814.	0.	.4
0.	8850840.	11896.	65.59	793.	0.	.4
0.	8501250.	11807.	63.78	771.	0.	.4
0.	8289350.	11141.	63.18	764.	0.	.4
0.	7907470.	10982.	64.91	785.	0.	.4
908557.	8055950.	10827.	68.38	827.	0.	.4
3833400.	8268070.	11113.	72.45	876.	0.	.6
8119940.	8692050.	12072.	73.35	887.	15630.	1.8
1477900.	9285410.	12480.	73.43	888.	0.	.4
0.	9910870.	13765.	73.20	885.	0.	.4
1232860.	10186800.	13692.	72.41	876.	0.	.5
1032790.	9444700.	12694.	71.24	862.	0.	.4
84436.	8914290.	12807.	70.37	851.	0.	.4
0.	8850840.	11896.	68.21	825.	0.	.4
424899.	8501250.	11807.	66.68	806.	0.	.4
0.	8289350.	11141.	65.88	797.	0.	.4
1226520.	7907470.	10982.	66.63	806.	0.	.4
0.	8055950.	10827.	68.63	830.	0.	.4
0.	8268070.	11113.	70.68	855.	0.	.4
3271940.	8692050.	12072.	72.12	872.	0.	.6
0.	9285410.	12480.	72.46	876.	0.	.4
0.	9910870.	13765.	71.74	868.	0.	.4
0.	10186800.	13692.	70.26	850.	0.	.4
0.	9444700.	12694.	69.01	835.	0.	.4
0.	8606900.	12807.	67.76	819.	0.	.4
0.	8850840.	11896.	66.24	801.	0.	.4
0.	8501250.	11807.	64.59	781.	0.	.4
0.	8289350.	11141.	63.84	772.	0.	.4
0.	7907470.	10982.	65.22	789.	0.	.4
0.	8055950.	10827.	68.37	827.	0.	.4
0.	8268070.	11113.	71.30	862.	0.	.4
1593430.	8692050.	12072.	72.90	882.	0.	.4
1314390.	9285410.	12480.	73.43	888.	0.	.4
0.	9910870.	13765.	73.13	884.	0.	.4
7050.	10186800.	13692.	72.42	876.	0.	.4
3144970.	9444700.	12694.	71.22	861.	0.	.6
0.	8606900.	12807.	69.70	843.	0.	.4
942789.	8850840.	11896.	68.21	825.	0.	.4
155198.	8501250.	11807.	66.69	807.	0.	.4
0.	8289350.	11141.	65.44	791.	0.	.4
0.	7907470.	10982.	66.14	800.	0.	.4
0.	8055950.	10827.	68.67	831.	0.	.4
0.	8268070.	11113.	71.18	861.	0.	.4
1895600.	8692050.	12072.	72.92	882.	0.	.4
8086980.	9285410.	12480.	73.35	887.	8896.	1.8
1826080.	9910870.	13765.	73.43	888.	0.	.6
2726920.	10186800.	13692.	72.65	879.	0.	.6
0.	9444700.	12694.	71.20	861.	0.	.4
0.	8606900.	12807.	69.57	841.	0.	.4
0.	8850840.	11896.	67.95	822.	0.	.4
0.	8501250.	11807.	66.36	802.	0.	.4
0.	8289350.	11141.	65.15	788.	0.	.4
0.	7907470.	10982.	65.56	793.	0.	.4
0.	8055950.	10827.	67.72	819.	0.	.4
0.	8268070.	11113.	70.57	853.	0.	.4
1792510.	8692050.	12072.	72.87	881.	0.	.4
3007000.	9285410.	12480.	73.43	888.	0.	.6
3621290.	9910870.	13765.	73.41	888.	0.	.7
7185550.	10186800.	13692.	72.58	878.	0.	1.9
2952860.	9444700.	12694.	71.25	862.	0.	.6
3623430.	8914290.	12807.	69.69	843.	0.	.8
0.	8850840.	11896.	68.20	825.	0.	.4
619223.	8501250.	11807.	66.67	806.	0.	.4
2059760.	8289350.	11141.	65.92	797.	0.	.5
4128480.	7907470.	10982.	66.66	806.	0.	.7
0.	8055950.	10827.	68.81	832.	0.	.4
61535.	8268070.	11113.	71.62	866.	0.	.4
7239740.	8692050.	12072.	73.22	886.	0.	1.5
8086980.	9285410.	12480.	73.35	887.	964.	1.8
0.	9910870.	13765.	72.96	882.	0.	.4
0.	10186800.	13692.	71.04	859.	0.	.4
0.	9444700.	12694.	70.30	850.	0.	.4
0.	8606900.	12807.	68.83	832.	0.	.4
0.	8850840.	11896.	67.18	812.	0.	.4
0.	8501250.	11807.	65.46	792.	0.	.4
0.	8289350.	11141.	64.15	776.	0.	.4
0.	7907470.	10982.	64.39	779.	0.	.4
0.	8055950.	10827.	66.20	801.	0.	.4
0.	8268070.	11113.	68.37	827.	0.	.4
0.	8692050.	12072.	70.57	853.	0.	.4
0.	9285410.	12480.	72.37	875.	0.	.4
0.	9910870.	13765.	72.38	875.	0.	.4
0.	10186800.	13692.	71.05	859.	0.	.4
0.	9444700.	12694.	69.43	840.	0.	.4
0.	8606900.	12807.	67.76	819.	0.	.4
0.	8850840.	11896.	66.00	798.	0.	.4
0.	8501250.	11807.	64.30	778.	0.	.4
0.	8289350.	11141.	63.79	771.	0.	.4
0.	7907470.	10982.	64.35	778.	0.	.4
0.	8055950.	10827.	65.99	798.	0.	.4
0.	8268070.	11113.	68.27	826.	0.	.4
0.	8692050.	12072.	69.70	843.	0.	.4
0.	9285410.	12480.	70.25	850.	0.	.4
0.	9910870.	13765.	70.35	851.	0.	.4
0.	10186800.	13692.	69.40	840.	0.	.4
0.	9444700.	12694.	67.79	829.	0.	.4
0.	8606900.	12807.	65.92	797.	0.	.4
0.	8850840.	11896.	63.88	772.	0.	.4
0.	8501250.	11807.	61.72	746.	0.	.4
0.	8289350.	11141.	59.98	725.	0.	.4
0.	7907470.	10982.	60.75	735.	0.	.4
0.	8055950.	10827.	63.65	770.	0.	.4
0.	8268070.	11113.	67.39	815.	0.	.4
0.	8692050.	12072.	70.28	850.	0.	.4
0.	9285410.	12480.	71.54	865.	0.	.4
0.	9910870.	13765.	71.54	865.	0.	.4
0.	10186800.	13692.	70.45	852.	0.	.4

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM, ALASKA

CRATER LAKE

MONTHLY REGULATION COMPUTATIONS

DESIGNED:
DRAWN: L.H.
CHECKED:
PREPARED:
SUPERVISED: [signature] Jr PE
APPROVED: [signature] Lt Col, CE
SUBMITTED: [signature]
RECOMMENDED: [signature]

SCALE NONE | DATE AUGUST 1965

FILE NUMBER Q-4-5-113

SHEET 1 OF 5

DESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 12

CORPS OF ENGINEERS

	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT	STORAGE EOM AF	SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
PROJECT NO 4			YEAR OF STUDY 2000											
JAN	15.	183.	961.65	949.84	960.58	85856.	0.	0.	9444700.	12694.	69.07	835.	0.	.4
FEB	15.	190.	937.92	926.21	937.44	75486.	0.	0.	8914290.	12807.	67.30	814.	0.	.4
MAR	20.	181.	913.78	901.34	913.31	65537.	0.	0.	8850840.	11896.	65.43	791.	0.	.4
APR	30.	185.	889.74	878.19	889.7	56258.	0.	0.	8501250.	11807.	63.50	768.	0.	.4
MAY	90.	179.	870.03	862.44	869.82	51732.	0.	0.	8289350.	11141.	61.94	749.	0.	.4
JUN	251.	177.	866.81	875.71	866.37	56094.	0.	0.	7907470.	10962.	61.80	747.	0.	.4
JUL	600.	160.	907.74	940.24	907.29	82098.	0.	0.	8055950.	10827.	64.90	785.	0.	.4
AUG	418.	161.	957.99	975.74	957.55	97871.	0.	0.	8268070.	11113.	68.82	832.	0.	.4
SEP	276.	171.	981.18	988.3	981.53	104116.	0.	0.	8692050.	12072.	70.58	854.	0.	.4
OCT	274.	174.	994.35	1000.48	993.89	110239.	0.	0.	9285410.	12480.	71.55	865.	0.	.4
NOV	66.	192.	992.94	985.41	992.46	102705.	0.	0.	9910870.	13765.	71.46	864.	0.	.4
DEC	97.	194.	979.41	973.42	978.92	96710.	0.	0.	10186800.	13692.	70.39	851.	0.	.4
PROJECT NO 4			YEAR OF STUDY 2001											
JAN	16.	183.	962.11	950.81	961.64	86436.	0.	0.	9444700.	12694.	69.15	836.	0.	.4
FEB	13.	18[illegible]	939.84	926.76	939.4	76563.	0.	0.	8606900.	12807.	67.45	816.	0.	.4
MAR	21.	181.	916.62	904.39	916.18	66736.	0.	0.	8850840.	11896.	65.66	794.	0.	.4
APR	42.	185.	893.70	883.03	893.22	58226.	0.	0.	8501250.	11807.	63.81	772.	0.	.4
MAY	194.	177.	884.39	885.72	883.93	57289.	0.	0.	8289350.	11141.	63.05	762.	0.	.4
JUN	462.	169.	907.50	929.27	907.05	76710.	0.	0.	7907470.	10982.	64.89	785.	0.	.4
JUL	454.	158.	949.46	965.64	949.02	94818.	0.	0.	8055950.	10827.	68.16	824.	0.	.4
AUG	371.	157.	982.82	996.05	982.38	107997.	0.	0.	8268070.	11113.	70.64	854.	0.	.4
SEP	467.	248.	1009.00	1022.00	1008.31	121000.	4878.	4334240.	8692050.	12072.	72.81	881.	0.	.6
OCT	762.	318.	1022.00	1022.00	1020.15	121000.	9111.	8086980.	9285410.	12480.	73.35	887.	27280.	1.8
NOV	294.	293.	1022.00	1022.00	1020.57	121000.	6328.	5618490.	9910870.	13765.	73.36	887.	0.	1.4
DEC	127.	305.	1011.00	1000.01	1009.37	110001.	7211.	6333480.	10186800.	13692.	72.50	878.	0.	1.6
PROJECT NO 4			YEAR OF STUDY 2002											
JAN	26.	186.	990.00	980.00	989.52	100001.	645.	556061.	9444700.	12694.	71.24	862.	0.	.4
FEB	16.	183.	969.68	959.36	969.21	90684.	0.	0.	8606900.	12807.	69.69	843.	0.	.4
MAR	23.	174.	949.25	936.73	948.59	81366.	0.	0.	8850840.	11896.	68.15	824.	0.	.4
APR	35.	177.	929.25	919.76	928.78	72907.	24.	19697.	8501250.	11807.	66.80	808.	0.	.4
MAY	112.	169.	915.31	910.89	914.85	69343.	0.	0.	8289350.	11141.	65.55	793.	0.	.4
JUN	436.	223.	925.42	940.00	924.81	82000.	3433.	2755080.	7907470.	10982.	66.32	802.	0.	.6
JUL	379.	157.	955.66	971.20	955.16	95604.	0.	0.	8055950.	10827.	68.63	830.	0.	.4
AUG	411.	156.	986.85	1002.52	986.41	111247.	0.	0.	8268070.	11113.	70.97	858.	0.	.4
SEP	465.	301.	1012.25	1022.00	1010.70	121000.	8030.	7128840.	8692050.	12072.	72.97	883.	0.	1.5
OCT	615.	318.	1022.00	1022.00	1020.15	121000.	9111.	8086980.	9285410.	12480.	73.35	887.	18242.	1.8
NOV	96.	188.	1016.50	1011.01	1016.03	115502.	0.	0.	9910870.	13765.	73.05	884.	0.	.4
DEC	62.	189.	1003.15	995.30	1002.67	107650.	0.	0.	10186800.	13692.	72.17	873.	0.	.4
PROJECT NO 4			YEAR OF STUDY 2003											
JAN	55.	179.	987.65	980.00	987.18	100001.	47.	40409.	9444700.	12694.	71.05	859.	0.	.4
FEB	43.	205.	970.00	960.00	969.48	91000.	1186.	1000420.	8606900.	12807.	69.71	843.	0.	.5
MAR	46.	192.	950.00	940.00	949.51	82000.	1107.	914383.	8850840.	11896.	68.22	825.	0.	.4
APR	32.	183.	930.00	920.00	929.52	73000.	370.	299178.	8501250.	11807.	66.69	807.	0.	.4
MAY	225.	224.	920.00	920.00	919.38	73000.	3442.	2745570.	8289350.	11141.	65.91	797.	0.	.6
JUN	309.	164.	929.56	939.16	929.13	81582.	0.	0.	7907470.	10982.	66.65	806.	0.	.4
JUL	423.	157.	957.47	975.32	957.05	97911.	0.	0.	8055950.	10827.	68.78	832.	0.	.4
AUG	333.	156.	986.67	997.52	986.23	108758.	0.	0.	8268070.	11113.	70.96	858.	0.	.4
SEP	535.	320.	1009.76	1022.00	1007.87	121000.	9149.	8119940.	8692050.	12072.	72.89	882.	531.	1.8
OCT	327.	318.	1022.00	1022.00	1020.15	121000.	9111.	8086980.	9285410.	12480.	73.35	887.	533.	1.8
NOV	84.	188.	1015.78	1009.56	1015.31	114780.	0.	0.	9910870.	13765.	73.00	883.	0.	.4
DEC	68.	199.	1002.07	994.58	1001.59	107286.	0.	0.	10186800.	13692.	72.10	872.	0.	.4
PROJECT NO 4			YEAR OF STUDY 2004											
JAN	37.	177.	985.84	977.10	985.37	98554.	0.	0.	9444700.	12694.	70.91	858.	0.	.4
FEB	26.	184.	967.03	956.30	966.52	89449.	0.	0.	8914290.	12807.	69.50	840.	0.	.4
MAR	20.	175.	946.36	935.83	945.90	79915.	0.	0.	8850840.	11896.	67.95	822.	0.	.4
APR	33.	177.	925.78	915.73	925.31	71294.	0.	0.	8501250.	11807.	66.38	803.	0.	.4
MAY	124.	170.	912.16	908.58	911.70	68437.	0.	0.	8289350.	11141.	65.33	790.	0.	.4
JUN	337.	166.	920.87	933.16	920.42	78587.	0.	0.	7907470.	10982.	65.98	798.	0.	.4
JUL	520.	171.	956.58	980.00	956.12	100001.	865.	719142.	8055950.	10827.	68.70	831.	0.	.4
AUG	608.	266.	1001.00	1022.00	1000.03	121000.	6893.	6122890.	8268070.	11113.	72.58	878.	0.	.9
SEP	353.	313.	1022.00	1022.00	1020.15	121000.	9149.	8119940.	8692050.	12072.	73.35	887.	2063.	1.8
OCT	373.	318.	1022.00	1022.00	1020.15	121000.	9111.	8086980.	9285410.	12480.	73.35	887.	3362.	1.8
NOV	151.	209.	1018.50	1015.01	1017.96	117501.	1299.	1150860.	9910870.	13765.	73.22	885.	0.	.5
DEC	89.	210.	1007.51	1000.01	1006.97	110001.	1351.	1184100.	10186800.	13692.	72.43	876.	0.	.5
PROJECT NO 4			YEAR OF STUDY 2005											
JAN	28.	190.	990.00	980.00	989.52	100001.	768.	662099.	9444700.	12694.	71.24	862.	0.	.4
FEB	38.	200.	970.00	960.00	969.50	91000.	909.	766785.	8606900.	12807.	69.71	843.	0.	.4
MAR	15.	174.	948.53	938.58	948.15	81192.	0.	0.	8850840.	11896.	68.17	824.	0.	.4
APR	43.	180.	929.19	920.00	928.72	73000.	207.	167551.	8501250.	11807.	66.63	806.	0.	.4
MAY	205.	205.	920.00	920.00	919.48	73000.	2213.	1765800.	8289350.	11141.	65.92	797.	0.	.5
JUN	323.	171.	930.00	940.00	929.54	82000.	420.	338896.	7907470.	10982.	66.68	806.	0.	.4
JUL	485.	182.	960.00	980.00	959.51	100001.	2168.	1809310.	8055950.	10827.	68.97	834.	0.	.4
AUG	560.	218.	1001.00	1022.00	1000.41	121000.	3945.	3505570.	8268070.	11113.	72.43	876.	0.	.5
SEP	433.	318.	1022.00	1022.00	1020.15	121000.	9149.	8119940.	8692050.	12072.	73.35	887.	6824.	1.8
OCT	311.	310.	1022.00	1022.00	1020.29	121000.	8662.	7688640.	9285410.	12480.	73.35	887.	0.	1.7
NOV	79.	183.	1015.48	1008.96	1015.01	114479.	0.	0.	9910870.	13765.	72.90	883.	0.	.4
DEC	43.	190.	999.90	990.85	999.42	105425.	0.	0.	10186800.	13692.	71.96	870.	0.	.4
PROJECT NO 4			YEAR OF STUDY 2006											
JAN	15.	180.	980.70	970.55	980.23	95275.	0.	0.	9444700.	12694.	70.40	852.	0.	.4
FEB	25.	185.	960.63	950.72	960.16	86361.	0.	0.	8606900.	12807.	69.04	835.	0.	.4
MAR	24.	176.	940.36	929.97	939.90	76999.	0.	0.	8850840.	11896.	67.49	816.	0.	.4
APR	51.	178.	920.48	910.96	920.01	69384.	0.	0.	8501250.	11807.	65.97	798.	0.	.4
MAY	166.	170.	910.58	910.20	910.12	69080.	0.	0.	8289350.	11141.	65.17	788.	0.	.4
JUN	372.	165.	924.45	938.70	924.00	81352.	0.	0.	7907470.	10982.	66.25	801.	0.	.4
JUL	491.	187.	959.35	980.00	958.87	100001.	1383.	1570330.	8055950.	10827.	68.92	833.	0.	.4
AUG	293.	156.	988.41	996.82	987.98	108407.	0.	0.	8268070.	11113.	71.10	860.	0.	.4
SEP	202.	167.	998.84	1000.87	998.39	110432.	0.	0.	8692050.	12072.	71.87	869.	0.	.4
OCT	276.	172.	1007.24	1013.62	1006.79	116805.	0.	0.	9285410.	12480.	72.41	876.	0.	.4
NOV	166.	189.	1012.24	1010.86	1011.76	115426.	0.	0.	9910870.	13765.	72.75	880.	0.	.4
DEC	75.	189.	1003.81	996.76	1003.33	108380.	0.	0.	10186800.	13692.	72.21	873.	0.	.4
PROJECT NO 4			YEAR OF STUDY 2007											
JAN	40.	178.	988.24	979.72	987.77	99863.	0.	0.	9444700.	12694.	71.10	860.	0.	.4
FEB	33.	192.	969.86	960.00	969.37	91000.	491.	414296.	8606900.	12807.	69.70	843.	0.	.4
MAR	36.	182.	950.00	940.00	949.53	82000.	492.	406842.	8850840.	11896.	68.22	825.	0.	.4
APR	37.	188.	930.00	920.00	929.52	73000.	668.	539276.	8501250.	11807.	66.69	807.	0.	.4
MAY	158.	169.	919.14	918.28	918.69	72314.	0.	0.	8289350.	11141.	65.87	797.	0.	.4
JUN	425.	262.	929.14	940.00	928.23	82000.	5789.	4664500.	7907470.	10982.	66.50	805.	0.	.9
JUL	538.	245.	960.00	980.00	959.31	100001.	5425.	4526480.	8055950.	10827.	68.95	834.	0.	.6
AUG	536.	194.	1001.00	1022.00	1000.52	121000.	2470.	2195100.	8268070.	11113.	72.31	875.	0.	.4
SEP	393.	318.	1022.00	1022.00	1020.15	121000.	9149.	8119940.	8692050.	12072.	73.35	887.	4443.	1.8
OCT	361.	318.	1022.00	1022.00	1020.15	121000.	9111.	8086980.	9285410.	12480.	73.35	887.	2624.	1.8
NOV	61.	188.	1014.40	1006.80	1013.92	113396.	0.	0.	9910870.	13765.	72.90	882.	0.	.4
DEC	42.	190.	997.65	988.50	997.16	104254.	0.	0.	10186800.	13692.	71.80	868.	0.	.4
PROJECT NO 4			YEAR OF STUDY 2008											
JAN	45.	180.	980.19	971.38	979.72	95942.	0.	0.	9444700.	12694.	70.45	852.	0.	.4
FEB	21.	185.	961.43	950.97	960.95	86488.	0.	0.	8914290.	12807.	69.10	836.	0.	.4
MAR	33.	176.	941.17	931.38	940.71	77690.	0.	0.	8850840.	11896.	67.55	817.	0.	.4
APR	56.	178.	922.43	913.49	921.97	70397.	0.	0.	8501250.	11807.	66.12	800.	0.	.4
MAY	166.	170.	913.15	912.31	912.69	70126.	0.	0.	8289350.	11141.	65.38	791.	0.	.4
JUN	337.	165.	924.72	936.63	924.28	80319.	0.	0.	7907470.	10962.	66.28	801.	0.	.4
JUL	585.	264.	958.32	980.00	957.37	100001.	6613.	5505670.	8055950.	10827.	68.80	832.	0.	.9
AUG	466.	181.	997.50	1015.01	997.03	117501.	1633.	1418200.	8268070.	11113.	71.77	868.	0.	.4
SEP	529.	318.	1018.50	1022.00	1016.63	121000.	9149.	8119940.	8692050.	12072.	73.21	885.	8702.	1.8
OCT	637.	318.	1022.00	1022.00	1020.15	121000.	9111.	8086980.	9285410.	12480.	73.35	887.	19594.	1.8
NOV	170.	228.	1018.50	1015.01	1017.88	117501.	2429.	2151870.	9910870.	13765.	73.21	885.	0.	.6
DEC	125.	247.	1007.51	1000.01	1006.82	110001.	3564.	3123420.	10186800.	13692.	72.42	876.	0.	.6
PROJECT NO 4			YEAR OF STUDY 2009											
JAN	41.	203.	990.00	980.00	989.47	100001.	1567.	1350880.	9444700.	12694.	71.24	862.	0.	.5
FEB	33.	195.	970.30	960.00	969.51	91000.	631.	532280.	8606900.	12807.	69.71	843.	0.	.4
MAR	37.	183.	950.00	940.00	949.52	82000.	554.	457696.	8850840.	11896.	68.22	825.	0.	.4
APR	38.	189.	930.00	920.00	929.52	73000.	727.	587293.	8501250.	11807.	66.69	807.	0.	.4
MAY	163.	169.	919.53	919.36	919.08	72626.	0.	0.	8289350.	11141.	65.89	797.	0.	.4
JUN	488.	330.	929.53	940.00	927.43	82000.	9841.	7921800.	7907470.	10982.	66.52	804.	0.	2.0
JUL	448.	157.	959.89	979.78	959.45	99892.	0.	0.	8055950.	10827.	68.96	834.	0.	.4
AUG	396.	155.	994.58	1009.39	994.15	114693.	0.	0.	8268070.	11113.	71.56	865.	0.	.4
SEP	291.	184.	1015.69	1022.00	1015.22	121000.	1166.	1036240.	8692050.	12072.	73.03	883.	0.	.4
OCT	489.	318.	1022.00	1022.00	1020.15	121000.	9111.	8086980.	9285410.	12480.	73.35	887.	10494.	1.8
NOV	151.	209.	1018.50	1015.01	1017.96	117501.	1299.	1150860.	9910870.	13765.	73.22	885.	0.	.5
DEC	97.	221.	1007.51	1000.01	1006.91	110001.	1966.	1723080.	10186800.	13692.	72.43	876.	0.	.6

	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT	STORAGE EOM AF
PROJECT NO 4			YEAR OF STUDY 2010			
JAN	19.	181.	990.00	980.00	989.53	10000[illegible]
FEB	15.	183.	969.72	959.21	969.25	[illegible]
MAR	25.	174.	947.06	938.06	946.69	81433
APR	36.	177.	929.43	920.00	928.96	73000
MAY	209.	209.	920.00	920.00	919.46	73000
JUN	361.	[illegible]	930.00	940.00	929.45	82000
JUL	502.	207.	960.00	980.00	959.40	100001
AUG	357.	155.	992.38	1006.77	[illegible]	112363
SEP	424.	279.	1013.30	1022.00	1012.23	121000
OCT	644.	318.	1022.00	1022.00	1020.15	121000
NOV	55.	186.	1016.03	1006.77	1015.59	113039
DEC	28.	190.	996.03	986.22	995.56	10614[illegible]
PROJECT NO 4			YEAR OF STUDY 2011			
JAN	13.	181.	975.11	964.19	974.64	92677.
FEB	13.	186.	953.50	942.31	953.02	83126.
MAR	20.	177.	931.92	921.23	931.46	73413.
APR	30.	181.	909.77	898.07	[illegible]	64408.
MAY	255.	172.	920.88	911.29	[illegible]	69495.
JUN	414.	201.	925.62	940.00	925.21	82000.
JUL	403.	157.	957.69	974.17	956.66	97095.
AUG	457.	155.	992.72	1011.76	992.29	115679.
SEP	316.	225.	1016.63	1022.00	1016.02	121000.
OCT	258.	257.	1022.00	1022.00	1021.17	121000.
NOV	141.	194.	1018.50	1015.01	1018.03	117501.
DEC	36.	189.	1005.58	996.15	1005.10	108074.
PROJECT NO 4			YEAR OF STUDY 2012			
JAN	23.	178.	986.56	976.98	986.10	98490.
FEB	19.	184.	966.46	955.95	965.99	88977.
MAR	53.	175.	947.54	938.97	947.00	81484.
APR	46.	190.	929.48	920.00	929.00	73000.
MAY	212.	211.	920.00	920.00	919.44	73000.
JUN	409.	257.	930.00	940.00	929.17	82000.
JUL	403.	157.	957.09	974.17	956.66	97395.
AUG	330.	156.	984.83	995.48	984.40	107737.
SEP	525.	302.	1006.75	1022.00	1007.19	121000.
OCT	291.	290.	1022.00	1022.00	1020.67	121000.
NOV	100.	188.	1016.74	1011.49	1016.27	115742.
DEC	77.	189.	1004.57	997.66	1004.09	108826.
PROJECT NO 4			YEAR OF STUDY 2013			
JAN	44.	187.	988.83	980.00	988.35	100001.
FEB	20.	183.	969.91	959.81	969.43	90909.
MAR	19.	174.	949.25	938.69	948.79	81348.
APR	25.	177.	928.45	918.21	927.98	72284.
MAY	243.	231.	919.10	920.00	918.46	73000.
JUN	466.	314.	930.00	940.00	928.20	82000.
JUL	461.	166.	960.00	980.00	959.55	100001.
AUG	372.	155.	993.31	1006.63	992.86	113314.
SEP	530.	319.	1016.31	1022.00	1012.43	121000.
OCT	208.	207.	1022.00	1022.00	1021.47	121000.
NOV	134.	192.	1018.50	1015.01	1018.02	117501.
DEC	48.	189.	1006.32	997.64	1005.84	108820.
PROJECT NO 4			YEAR OF STUDY 2014			
JAN	35.	178.	988.82	980.00	988.35	100001.
FEB	16.	183.	969.68	959.36	969.21	90684.
MAR	21.	174.	948.92	938.48	948.46	81242.
APR	37.	177.	929.11	919.75	928.65	72899.
MAY	207.	205.	919.87	920.00	919.35	73000.
JUN	310.	164.	929.64	939.28	929.19	81642.
JUL	410.	157.	956.80	974.33	956.37	97165.
AUG	421.	155.	990.63	1006.93	990.20	113465.
SEP	379.	252.	1014.46	1022.00	1013.73	121000.
OCT	224.	223.	1022.00	1022.00	1021.39	121000.
NOV	361.	318.	1022.00	1022.00	1020.15	121000.
DEC	76.	254.	1011.00	1000.01	1010.22	110001.
PROJECT NO 4			YEAR OF STUDY 2015			
JAN	10.	178.	989.66	979.31	989.19	99657.
FEB	10.	183.	968.65	957.99	968.17	89995.
MAR	15.	174.	947.15	936.32	946.69	80163.
APR	25.	177.	925.74	915.16	925.28	71066.
MAY	122.	170.	911.42	907.68	910.96	68072.
JUN	323.	166.	919.20	930.73	918.75	77368.
JUL	436.	158.	949.63	968.53	949.19	94411.
AUG	339.	157.	979.82	991.11	979.36	105551.
SEP	413.	254.	1000.55	1010.00	999.78	115009.
OCT	110.	172.	1006.16	1002.33	1005.71	111162.
NOV	38.	192.	993.13	983.93	992.64	101965.
DEC	22.	195.	972.30	960.67	971.81	91271.
PROJECT NO 4			YEAR OF STUDY 2016			
JAN	17.	186.	949.20	937.73	948.72	80866.
FEB	15.	192.	925.90	914.08	925.41	70632.
MAR	19.	184.	901.35	888.62	900.87	62449.
APR	33.	189.	876.23	863.85	875.75	51156.
MAY	160.	181.	861.61	859.37	861.14	49812.
JUN	411.	175.	878.21	897.04	877.75	63819.
JUL	489.	164.	920.76	944.48	920.32	83794.
AUG	291.	162.	953.12	961.76	952.68	91705.
SEP	311.	173.	970.79	979.82	970.33	99913.
OCT	114.	177.	975.89	971.37	975.43	95986.
NOV	46.	199.	961.86	951.75	961.36	86875.
DEC	35.	202.	940.31	928.88	939.81	76553.
PROJECT NO 4			YEAR OF STUDY 2017			
JAN	12.	193.	914.91	900.94	914.42	65379.
FEB	13.	202.	887.81	874.68	887.31	54872.
MAR	18.	195.	858.57	842.47	858.08	43988.
APR	42.	202.	827.00	811.54	826.50	34462.
MAY	161.	196.	806.49	801.44	805.99	32288.
JUN	302.	191.	813.82	826.19	813.33	36858.
JUL	511.	178.	855.99	885.79	855.53	59317.
AUG	426.	171.	905.33	924.88	904.88	74953.
SEP	480.	178.	944.84	964.80	944.37	92921.
OCT	515.	176.	986.16	1007.53	985.70	113765.
NOV	167.	190.	1006.15	1004.77	1005.67	112384.
DEC	45.	191.	995.79	986.81	995.30	103405.
PROJECT NO 4			YEAR OF STUDY 2018			
JAN	20.	180.	976.54	966.28	976.07	93515.
FEB	22.	186.	956.12	945.95	955.64	84383.
MAR	17.	177.	934.88	923.80	934.41	74523.
APR	29.	180.	912.52	901.13	912.05	65495.
MAY	227.	172.	905.45	909.65	904.97	68867.
JUN	428.	207.	924.83	940.00	924.30	82000.
JUL	446.	157.	959.76	979.93	959.33	99768.
AUG	456.	167.	997.27	1015.01	996.82	117501.
SEP	376.	317.	1018.50	1022.00	1016.67	121000.
OCT	402.	318.	1022.00	1022.00	1020.15	121000.
NOV	51.	188.	1013.79	1005.59	1013.31	112794.
DEC	51.	190.	996.99	988.39	996.50	104198.
PROJECT NO 4			YEAR OF STUDY 2019			
JAN	25.	180.	978.74	969.10	978.27	94640
FEB	89.	185.	962.85	956.63	962.37	89303
MAR	21.	175.	946.13	935.65	945.67	79828
APR	20.	178.	924.60	913.55	924.13	70419
MAY	108.	171.	908.68	903.81	908.22	66524
JUN	314.	167.	914.69	925.57	914.24	75229
JUL	384.	160.	940.76	955.97	940.32	88977
AUG	271.	160.	963.75	971.54	963.31	95770
SEP	389.	170.	984.54	997.55	984.09	108772
OCT	184.	173.	998.18	998.81	997.72	109403
NOV	178.	191.	997.99	997.18	997.51	108598
DEC	120.	191.	992.77	988.37	992.29	104188

CRATER LAKE

MONTHLY REGULATION COMPUTATIONS

W/RULE CURVE OPERATION

U. S. ARMY

STORAGE EOM AF	SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRIMARY ENERGY KWH	PRIMARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
STUDY 2010								
100001.	215.	185157.	9444700.	12694.	71.25	862.	0.	.4
93628.	0.	0.	8606900.	12807.	69.69	843.	0.	.4
81433.	0.	0.	8850840.	11896.	68.16	824.	0.	.4
73000.	35.	28551.	8501250.	11807.	66.65	806.	0.	.4
73000.	2457.	1961740.	8289350.	11141.	65.92	797.	0.	.5
82000.	2687.	2162420.	7907470.	10982.	66.67	806.	0.	.5
100001.	3213.	2681270.	8055950.	10827.	68.96	834.	0.	.5
112383.	0.	0.	8268070.	11113.	71.41	864.	0.	.4
121000.	6741.	5986680.	8692050.	12072.	73.02	883.	0.	1.1
121000.	9111.	8086980.	9285410.	12480.	73.35	887.	20025.	1.0
113035.	0.	0.	9910870.	13765.	72.88	881.	0.	.4
103614.	0.	0.	10186800.	13692.	71.68	867.	0.	.4
STUDY 2011								
92677.	0.	0.	9444700.	12694.	70.00	848.	0.	.4
83126.	0.	0.	8606900.	12807.	68.90	828.	0.	.4
73413.	0.	0.	8850840.	11896.	66.85	808.	0.	.4
64408.	0.	0.	8501250.	11807.	65.11	787.	0.	.4
69499.	0.	0.	8289350.	11141.	64.70	782.	0.	.4
82000.	2284.	1833500.	7907470.	10982.	66.34	802.	0.	.5
97095.	0.	0.	8055950.	10827.	68.75	831.	0.	.4
111629.	0.	0.	8268070.	11113.	71.43	864.	0.	.4
121000.	3594.	3193620.	8692050.	12072.	73.13	884.	0.	.6
121000.	5411.	4807150.	9285410.	12480.	73.41	888.	0.	.8
117501.	705.	624632.	9910870.	13765.	73.22	886.	0.	.4
108074.	0.	0.	10186800.	13692.	72.32	875.	0.	.4
STUDY 2012								
98490.	0.	0.	9444700.	12694.	70.97	858.	0.	.4
88977.	0.	0.	8914290.	12807.	69.46	840.	0.	.4
81484.	0.	0.	8850840.	11896.	68.03	823.	0.	.4
73000.	801.	646225.	8501250.	11807.	66.65	806.	0.	.4
73000.	2643.	2108730.	8289350.	11141.	65.92	797.	0.	.5
87000.	5533.	4462810.	7907470.	10982.	66.65	806.	0.	.8
97095.	0.	0.	8055950.	10827.	68.75	831.	0.	.4
107737.	0.	0.	8268070.	11113.	70.81	856.	0.	.4
121000.	8059.	7154550.	8692050.	12072.	72.85	881.	0.	1.5
121000.	7432.	6599020.	9285410.	12480.	73.36	887.	0.	1.3
115742.	0.	0.	9910870.	13765.	73.07	884.	0.	.4
108826.	0.	0.	10186800.	13692.	72.25	874.	0.	.4
STUDY 2013								
100001.	562.	483850.	9444700.	12694.	71.15	860.	0.	.4
93909.	17.	14494.	8606900.	12807.	69.82	844.	0.	.4
81348.	0.	0.	8850840.	11896.	68.17	824.	0.	.4
72284.	0.	0.	8501250.	11807.	66.58	805.	0.	.4
73000.	3817.	3040610.	8289350.	11141.	65.82	796.	0.	.6
82000.	8914.	7181920.	7907470.	10982.	66.58	805.	0.	1.7
100001.	693.	578369.	8055950.	10827.	68.97	834.	0.	.4
113314.	0.	0.	8268070.	11113.	71.47	864.	0.	.4
121000.	9147.	8119940.	8692050.	12072.	73.05	884.	4832.	1.8
121000.	2339.	2078570.	9285410.	12480.	73.43	888.	0.	.5
117501.	288.	255172.	9910870.	13765.	73.22	886.	0.	.6
108820.	0.	0.	10186800.	13692.	72.36	875.	0.	.4
STUDY 2014								
100001.	3.	2582.	9444700.	12694.	71.15	860.	0.	.4
90684.	0.	0.	8606900.	12807.	69.69	843.	0.	.4
81242.	0.	0.	8850840.	11896.	68.15	824.	0.	.4
72899.	16.	13043.	8501250.	11807.	66.73	807.	0.	.4
73000.	2237.	1786820.	8289350.	11141.	65.94	797.	0.	.5
81642.	0.	0.	7907470.	10982.	66.65	806.	0.	.4
97165.	0.	0.	8055950.	10827.	68.73	831.	0.	.4
113465.	0.	0.	8268070.	11113.	71.28	862.	0.	.4
121000.	5160.	4584630.	8692050.	12072.	73.07	884.	0.	.7
121000.	3322.	2951900.	9285410.	12480.	73.43	888.	0.	.6
121000.	7775.	6901120.	9910870.	13765.	73.35	887.	2539.	1.0
110001.	4084.	3589760.	10186800.	13692.	72.64	878.	0.	.7
STUDY 2015								
99657.	0.	0.	9444700.	12694.	71.22	861.	0.	.4
89995.	0.	0.	8606900.	12807.	69.62	842.	0.	.4
80163.	0.	0.	8850840.	11896.	68.01	822.	0.	.4
71066.	0.	0.	8501250.	11807.	66.37	803.	0.	.4
68072.	0.	0.	8289350.	11141.	65.27	789.	0.	.4
77368.	0.	0.	7907470.	10982.	65.85	796.	0.	.4
94411.	0.	0.	8055950.	10827.	68.17	824.	0.	.4
105551.	0.	0.	8268070.	11113.	70.40	851.	0.	.4
115000.	5146.	4481910.	8692050.	12072.	71.97	870.	0.	.7
111162.	0.	0.	9285410.	12480.	72.38	875.	0.	.4
101965.	0.	0.	9910870.	13765.	71.47	864.	0.	.4
91271.	0.	0.	10186800.	13692.	69.88	845.	0.	.4
STUDY 2016								
80866.	0.	0.	9444700.	12694.	68.17	824.	0.	.4
70632.	0.	0.	8914290.	12807.	66.39	803.	0.	.4
60448.	0.	0.	8850840.	11896.	64.43	779.	0.	.4
51156.	0.	0.	8501250.	11807.	62.41	755.	0.	.4
49812.	0.	0.	8289350.	11141.	61.26	741.	0.	.4
63819.	0.	0.	7907470.	10982.	62.54	756.	0.	.4
83794.	0.	0.	8055950.	10827.	65.96	798.	0.	.4
91705.	0.	0.	8268070.	11113.	68.45	828.	0.	.4
99913.	0.	0.	8692050.	12072.	69.75	844.	0.	.4
95986.	0.	0.	9285410.	12480.	70.16	849.	0.	.4
86875.	0.	0.	9910870.	13765.	69.13	836.	0.	.4
76553.	0.	0.	10186800.	13692.	67.48	816.	0.	.5
STUDY 2017								
65379.	0.	0.	9444700.	12694.	65.52	792.	0.	.4
54872.	0.	0.	8606900.	12807.	63.34	766.	0.	.5
43988.	0.	0.	8850840.	11896.	61.00	738.	0.	.4
34462.	0.	0.	8501250.	11807.	58.42	706.	0.	.5
32288.	0.	0.	8289350.	11141.	56.74	686.	0.	.4
38858.	0.	0.	7907470.	10982.	57.32	693.	0.	.4
54317.	0.	0.	8055950.	10827.	60.73	734.	0.	.4
74953.	0.	0.	8268070.	11113.	64.72	783.	0.	.4
92921.	0.	0.	8692050.	12072.	67.80	820.	0.	.4
113765.	0.	0.	9285410.	12480.	70.90	857.	0.	.4
112384.	0.	0.	9910870.	13765.	72.36	879.	0.	.4
103405.	0.	0.	10186800.	13692.	71.67	867.	0.	.4
STUDY 2018								
93515.	0.	0.	9444700.	12694.	70.19	849.	0.	.4
84183.	0.	0.	8606900.	12807.	68.70	831.	0.	.4
74523.	0.	0.	8850840.	11896.	67.07	811.	0.	.4
65495.	0.	0.	8501250.	11807.	65.33	790.	0.	.4
68867.	0.	0.	8289350.	11141.	64.71	783.	0.	.4
82000.	2475.	1985450.	7907470.	10982.	66.28	802.	0.	.5
99769.	0.	0.	8055950.	10827.	68.95	834.	0.	.4
117501.	784.	680730.	8268070.	11113.	71.75	868.	0.	.4
121000.	9045.	8027710.	8692050.	12072.	73.21	885.	0.	1.8
121000.	9111.	8086980.	9285410.	12480.	73.35	887.	5145.	1.8
112794.	0.	0.	9910870.	13765.	72.86	881.	0.	.4
104198.	0.	0.	10186800.	13692.	71.75	868.	0.	.4
STUDY 2019								
99640.	0.	0.	9444700.	12694.	70.34	851.	0.	.4
89303.	0.	0.	8606900.	12807.	69.20	837.	0.	.4
79828.	0.	0.	8850840.	11896.	67.93	822.	0.	.4
70419.	0.	0.	8501250.	11807.	66.29	802.	0.	.4
66524.	0.	0.	8289350.	11141.	65.01	786.	0.	.4
75229.	0.	0.	7907470.	10982.	65.48	792.	0.	.4
88977.	0.	0.	8055950.	10827.	67.50	816.	0.	.4
95774.	0.	0.	8268070.	11113.	69.25	837.	0.	.4
108772.	0.	0.	8692050.	12072.	70.78	856.	0.	.4
109401.	0.	0.	9285410.	12480.	71.82	869.	0.	.4
108590.	0.	0.	9910870.	13765.	71.83	869.	0.	.4
104186.	0.	0.	10186800.	13692.	71.44	864.	0.	.4

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: K.H.
CHECKED:
PREPARED:

SNETTISHAM, ALASKA

CRATER LAKE

MONTHLY REGULATION COMPUTATIONS

SUPERVISED: P.E.
SUBMITTED:
RECOMMENDED:
APPROVED: Lt Col CE

SCALE NONE
DATE AUGUST 1965
FILE NUMBER Q-4-5-113
SHEET 2 OF 3

	FLOW NATL CFS	FLOW REG CFS	POOL ELEVATION AVERAGE FTMSL	POOL ELEVATION EOM FTMSL	HEAD AVERAGE FT	STORAGE EOM AF	SECONDARY SPILL AF	SECONDARY ENERGY KWH	PRI[MARY] ENERGY KWH
PROJECT NO 4				YEAR OF STUDY 2020					
JAN	33.	180.	979.31	970.25	978.64	95126.	0.	0.	9444700.
FEB	16.	185.	959.47	948.[illegible]	958.[illegible]	[illegible]	0.	0.	8914290.
MAR	21.	176.	937.37	927.22	937.51	77802.	0.	0.	8850840.
APR	25.	180.	915.05	[illegible]	[illegible]	65618.	0.	0.	8501250.
MAY	93.	173.	897.05	[illegible]	897.33	64657.	0.	0.	8289350.
JUN	267.	171.	898.78	905.91	894.32	67366.	0.	0.	7907470.
JUL	506.	162.	933.43	956.99	930.01	86648.	0.	0.	8055950.
AUG	518.	156.	978.12	1001.25	977.68	113625.	0.	0.	8268070.
SEP	35[illegible].	184.	1011.02	1022.[illegible]	1011.15	121000.	11032.	982[illegible].	8692050.
OCT	12[illegible].	170.	1017.74	1016.36	1016.81	118776.	0.	0.	9285410.
NOV	77.	189.	1009.85	1003.12	1003.37	111574.	0.	0.	9910870.
DEC	22.	191.	992.71	982.78	992.23	111144.	0.	0.	10186800.
PROJECT NO 4				YEAR OF STUDY 2021					
JAN	9.	181.	970.65	959.02	970.18	90510.	0.	0.	9444700.
FEB	10.	186.	948.12	937.2[illegible]	947.64	80618.	0.	0.	8606900.
MAR	15.	178.	925.51	913.73	925.05	73518.	0.	0.	8850840.
APR	25.	183.	902.03	890.27	901.56	61111.	0.	0.	8501250.
MAY	185.	175.	891.02	891.77	890.96	61709.	0.	0.	8289350.
JUN	226.	171.	895.8[illegible]	899.86	895.15	64937.	0.	0.	7907470.
JUL	497.	163.	924.22	948.61	923.78	85444.	0.	0.	8055950.
AUG	621.	158.	976.05	1003.65	977.33	111406.	0.	0.	8268070.
SEP	278.	229.	1008.96	1010.0[illegible]	1008.65	119000.	5535.	4855610.	8692050.
OCT	142.	177.	1008.15	1006.40	1007.70	113146.	0.	0.	9285410.
NOV	163.	190.	1004.66	1003.03	1004.18	111515.	0.	0.	9910870.
DEC	115.	190.	998.38	991.74	997.90	106868.	0.	0.	10186800.
PROJECT NO 4				YEAR OF STUDY 2022					
JAN	48.	179.	985.68	977.02	985.21	98810.	0.	0.	9444700.
FEB	15.	184.	967.22	956.82	966.76	87611.	0.	0.	8606900.
MAR	13.	173.	945.65	934.40	945.39	77660.	0.	0.	8850840.
APR	29.	178.	924.17	913.91	923.93	73564.	0.	0.	8501250.
MAY	177.	170.	914.43	914.16	913.98	73984.	0.	0.	8289350.
JUN	342.	165.	926.78	939.96	926.51	81500.	0.	0.	7907470.
JUL	392.	157.	955.40	971.45	954.96	95701.	0.	0.	8055950.
AUG	354.	157.	983.91	996.02	983.47	108008.	0.	0.	8268070.
SEP	499.	225.	1009.01	1022.00	1009.40	121000.	3521.	3128760.	8692050.
OCT	241.	240.	1022.00	1022.00	1021.34	121000.	4367.	3880300.	9285410.
NOV	169.	227.	1018.50	1015.01	1017.88	117501.	2373.	2099600.	9910870.
DEC	44.	189.	1006.08	997.15	1005.60	108571.	0.	0.	10186800.
PROJECT NO 4				YEAR OF STUDY 2023					
JAN	84.	223.	988.57	980.00	987.96	100001.	2761.	2376000.	9444700.
FEB	23.	185.	970.00	960.00	969.52	91000.	76.	64110.	8606900.
MAR	18.	174.	949.38	938.75	948.92	81379.	0.	0.	8850840.
APR	42.	167.	929.38	920.00	928.91	73000.	337.	272027.	8501250.
MAY	216.	216.	920.00	920.00	919.42	73000.	2889.	2304660.	8289350.
JUN	440.	336.	930.00	940.00	927.74	82000.	10337.	8323990.	7907470.
JUL	474.	181.	960.00	980.00	979.53	100001.	1492.	1245170.	8055950.
AUG	442.	157.	997.50	1015.01	997.07	117501.	158.	137221.	8268070.
SEP	216.	258.	1012.51	1010.01	1011.68	115001.	5481.	4825680.	8692050.
OCT	320.	222.	1016.00	1022.00	1015.40	121000.	3165.	2812420.	9285410.
NOV	93.	188.	1016.32	1010.05	1015.85	115321.	0.	0.	9910870.
DEC	52.	189.	1002.17	993.69	1001.67	106844.	0.	0.	10186800.
PROJECT NO 4				YEAR OF STUDY 2024					
JAN	25.	179.	984.19	974.70	983.73	97353.	0.	0.	9444700.
FEB	23.	184.	964.40	954.09	963.92	88047.	0.	0.	8914290.
MAR	21.	175.	943.58	933.08	943.12	78540.	0.	0.	8850840.
APR	32.	178.	922.56	912.05	922.10	67821.	0.	0.	8501250.
MAY	156.	170.	910.91	909.77	910.45	68907.	0.	0.	8289350.
JUN	404.	183.	924.88	940.00	924.41	82000.	1089.	873568.	7907470.
JUL	606.	313.	960.00	980.00	958.23	100001.	9595.	7996280.	8055950.
AUG	396.	155.	994.80	1009.61	994.37	114804.	0.	0.	8268070.
SEP	243.	236.	1009.81	1010.01	1009.16	115001.	4189.	1679730.	8692050.
OCT	231.	171.	1013.67	1017.34	1013.22	118667.	0.	0.	9285410.
NOV	101.	187.	1012.09	1006.89	1011.61	113417.	0.	0.	9910870.
DEC	71.	190.	999.50	992.16	999.01	106080.	0.	0.	10186800.
PROJECT NO 4				YEAR OF STUDY 2025					
JAN	34.	179.	983.21	974.26	982.74	97130.	0.	0.	9444700.
FEB	18.	184.	963.99	953.77	963.51	87863.	0.	0.	8606900.
MAR	25.	172.	943.46	933.20	943.00	78601.	0.	0.	8850840.
APR	41.	178.	923.38	913.56	922.92	73427.	0.	0.	8501250.
MAY	177.	170.	914.08	914.60	913.63	70842.	0.	0.	8289350.
JUN	361.	173.	927.30	940.00	926.84	82000.	493.	396556.	7907470.
JUL	511.	218.	960.00	960.00	959.41	100001.	3766.	3142580.	8055950.
AUG	434.	154.	997.16	1014.33	996.73	117163.	0.	0.	8268070.
SEP	622.	319.	1018.16	1022.00	1016.29	121000.	9149.	8119940.	8692050.
OCT	355.	318.	1022.00	1022.00	1020.15	121000.	9111.	8086980.	9285410.
NOV	125.	188.	1018.25	1014.51	1017.78	117251.	0.	0.	9910870.
DEC	99.	216.	1007.26	1000.01	1006.68	110001.	1713.	1501030.	10186800.
PROJECT NO 4				YEAR OF STUDY 2026					
JAN	92.	214.	990.00	980.00	989.43	100001.	2243.	1933520.	9444700.
FEB	61.	203.	970.00	960.00	969.43	91000.	1075.	906803.	8606900.
MAR	33.	172.	950.00	940.00	949.53	82000.	303.	254689.	8850840.
APR	92.	203.	930.00	920.00	929.44	73000.	1567.	1259280.	8501250.
MAY	194.	194.	920.00	920.00	919.51	73000.	1537.	1226590.	8289350.
JUN	473.	321.	930.00	940.00	928.07	82000.	9327.	7515210.	7907470.
JUL	691.	337.	963.71	987.42	961.47	103712.	11141.	9316440.	8055950.
AUG	684.	320.	1004.71	1022.00	1007.91	121000.	10258.	9104320.	8268070.
SEP	301.	300.	1022.00	1022.00	1020.46	121000.	8116.	7206980.	8692050.
OCT	428.	318.	1022.00	1022.00	1020.15	121000.	9111.	8086980.	9285410.
NOV	74.	188.	1015.18	1008.35	1014.71	114178.	0.	0.	9910870.
DEC	73.	190.	998.05	987.74	997.56	103873.	0.	0.	10186800.
PROJECT NO 4				YEAR OF STUDY 2027					
JAN	79.	179.	981.54	975.33	981.07	97668.	0.	0.	9444700.
FEB	26.	184.	965.53	955.72	965.05	88862.	0.	0.	8606900.
MAR	31.	175.	945.86	935.99	945.40	79997.	0.	0.	8850840.
APR	29.	177.	925.67	915.34	925.20	71137.	0.	0.	8501250.
MAY	101.	171.	909.95	904.57	909.50	66828.	0.	0.	8289350.
JUN	340.	167.	917.39	930.72	916.94	77113.	0.	0.	7907470.
JUL	431.	158.	948.66	967.07	948.22	93838.	0.	0.	8055950.
AUG	367.	157.	980.25	993.41	979.81	106703.	0.	0.	8268070.
SEP	480.	239.	1007.70	1022.00	1007.04	121000.	4346.	3861660.	8692050.
OCT	243.	242.	1022.00	1022.00	1021.33	121000.	4490.	3989550.	9285410.
NOV	192.	210.	1018.50	1015.01	1017.96	117501.	1359.	1204030.	9910870.
DEC	101.	223.	1007.51	1000.01	1006.90	110001.	2089.	1830860.	10186800.
PROJECT NO 4				YEAR OF STUDY 2028					
JAN	59.	221.	990.00	980.00	989.40	100001.	2673.	2304100.	9444700.
FEB	70.	226.	970.00	960.00	969.37	91000.	2453.	2074010.	8914290.
MAR	36.	182.	950.00	940.00	947.53	82000.	492.	406924.	8850840.
APR	35.	180.	930.00	920.00	929.52	73000.	547.	443237.	8501250.
MAY	138.	169.	917.56	915.16	917.13	71067.	0.	0.	8289350.
JUN	306.	165.	925.00	934.83	924.55	79419.	0.	0.	7907470.
JUL	459.	157.	955.04	975.25	954.51	97628.	0.	0.	8055950.
AUG	330.	156.	985.91	996.57	985.47	108281.	0.	0.	8268070.
SEP	543.	320.	1009.28	1022.00	1007.39	121000.	9149.	8119940.	8692050.
OCT	300.	299.	1022.00	1022.00	1020.47	121000.	7985.	7089020.	9285410.
NOV	123.	188.	1018.13	1014.26	1017.66	117130.	0.	0.	9910870.
DEC	62.	189.	1006.44	998.63	1005.96	109311.	0.	0.	10186800.
PROJECT NO 4				YEAR OF STUDY 2029					
JAN	35.	186.	989.31	980.00	988.83	100001.	503.	430719.	9444700.
FEB	47.	209.	970.00	960.00	969.46	91000.	1408.	1187650.	8606900.
MAR	68.	194.	950.00	940.00	949.51	82000.	1233.	1015920.	8850840.
APR	57.	208.	930.00	920.00	929.46	73000.	1857.	1499090.	8501250.
MAY	203.	203.	920.00	920.00	919.47	73000.	2090.	1667860.	8289350.
JUN	531.	350.	932.70	944.41	929.73	83764.	11034.	8904520.	7907470.
JUL	830.	224.	983.20	1022.00	982.57	121000.	4374.	3886710.	8055950.
AUG	858.	318.	1022.00	1022.00	1020.15	121000.	10256.	9104320.	8268070.
SEP	491.	318.	1022.00	1022.00	1020.15	121000.	9149.	8119940.	8692050.
OCT	260.	255.	1022.00	1022.00	1021.14	121000.	5533.	4915390.	9285410.
NOV	108.	188.	1017.22	1012.45	1016.75	116223.	0.	0.	9910870.
DEC	38.	187.	1003.12	993.79	1002.64	106895.	0.	0.	10186800.

CRATER LAKE

MONTHLY REGULATION COMPUTATIO[N]
W/RULE CURVE OPERATION

ARY POWER KW	KW/CFS	KWH/AF	WASTE AF	TAIL WATER
12694.	70.38	851.	0.	.4
12807.	68.95	834.	0.	.4
11896.	67.31	814.	0.	.4
11807.	65.58	793.	0.	.4
11141.	64.14	776.	0.	.4
10982.	64.20	776.	0.	.4
10827.	66.70	807.	0.	.4
11113.	70.27	850.	0.	.4
12072.	72.77	880.	0.	.4
12480.	73.27	886.	0.	.4
13765.	72.90	878.	0.	.4
13692.	71.45	864.	0.	.4
12694.	69.76	844.	0.	.4
12807.	68.08	823.	0.	.4
11896.	66.36	802.	0.	.4
11807.	64.48	780.	0.	.4
11141.	63.56	769.	0.	.4
10982.	63.94	773.	0.	.4
10827.	66.22	801.	0.	.4
11113.	70.27	850.	0.	.4
12072.	72.48	877.	0.	.8
12480.	72.49	877.	0.	.4
13765.	72.27	874.	0.	.4
13692.	71.85	869.	0.	.4
12694.	70.09	857.	0.	.4
12807.	69.51	841.	0.	.4
11896.	67.91	821.	0.	.4
11807.	66.27	801.	0.	.4
11141.	65.47	792.	0.	.4
10982.	66.45	804.	0.	.4
10827.	68.62	830.	0.	.4
11113.	70.73	855.	0.	.4
12072.	72.75	880.	0.	.6
12480.	73.42	888.	0.	.6
13765.	73.21	885.	0.	.6
13692.	72.89	875.	0.	.4
12694.	71.12	860.	0.	.6
12807.	69.71	843.	0.	.4
11896.	68.18	825.	0.	.4
11807.	66.65	806.	0.	.4
11141.	65.92	797.	0.	.5
10982.	66.54	805.	0.	2.2
10827.	68.97	834.	0.	.4
11113.	71.77	868.	0.	.4
12072.	72.76	880.	0.	.8
12480.	73.10	884.	0.	.6
13765✓	73.04	883.	0.	.4
13692.	72.11	872.	0.	.4
12694.	70.77	856.	0.	.4
12807.	69.31	838.	0.	.4
11896.	67.74	819.	0.	.4
11807.	66.13	800.	0.	.4
11141.	65.20	789.	0.	.4
10982.	66.28	802.	0.	.4
10827.	68.87	833.	0.	1.7
11113.	71.58	866.	0.	.4
12072.	72.59	878.	0.	.6
12480.	72.82	881.	0.	.4
13765.	72.74	880.	0.	.4
13692.	71.93	870.	0.	.4
12694.	70.69	855.	0.	.4
12807.	69.28	838.	0.	.4
11896.	67.75	819.	0.	.4
11807.	66.19	800.	0.	.4
11141.	65.44	791.	0.	.4
10982.	66.47	804.	0.	.4
10827.	68.96	834.	0.	.5
11113.	71.75	868.	0.	.4
12072.	73.19	885.	2291.	1.8
12480.	73.35	887.	2255.	1.8
13765.	73.21	885.	0.	.4
13692.	72.41	876.	0.	.5
12694.	71.24	862.	0.	.5
12807.	69.71	843.	0.	.5
11896.	68.22	825.	0.	.4
11807.	66.69	807.	0.	.5
11141.	65.92	797.	0.	.4
10982.	66.57	805.	0.	1.9
10827.	69.10	836.	0.	2.2
11113.	72.77	880.	5041.	1.9
12072.	73.36	887.	0.	1.5
12480.	73.35	887.	6744.	1.8
13765.	72.96	882.	0.	.4
13692.	71.83	869.	0.	.4
12694.	70.55	853.	0.	.4
12807.	69.39	839.	0.	.4
11896.	67.91	821.	0.	.4
11807.	66.37	803.	0.	.4
11141.	65.12	787.	0.	.4
10982.	65.70	795.	0.	.4
10827.	68.10	824.	0.	.4
11113.	70.43	852.	0.	.4
12072.	72.73	880.	0.	.6
12480.	73.42	888.	0.	.6
13765.	73.22	885.	0.	.5
13692.	72.43	876.	0.	.6
12694.	71.23	861.	0.	.6
12807.	69.70	843.	0.	.6
11896.	68.22	825.	0.	.4
11807.	66.69	807.	0.	.4
11141.	65.75	795.	0.	.4
10982.	66.30	802.	0.	.4
10827.	68.59	829.	0.	.4
11113.	70.89	857.	0.	.4
12072.	72.88	881.	526.	1.8
12480.	73.36	887.	0.	1.5
13765.	73.20	885.	0.	.4
13692.	72.37	875.	0.	.4
12694.	71.19	861.	0.	.4
12807.	69.71	843.	0.	.5
11896.	68.22	825.	0.	.4
11807.	66.69	807.	0.	.5
11141.	65.92	797.	0.	.5
10982.	66.69	807.	0.	2.4
10827.	71.52	865.	0.	.6
11113.	73.35	887.	33192.	1.8
12072.	73.35	887.	10275.	1.8
12480.	73.41	888.	0.	.8
13765.	73.10	884.	0.	.4
13692.	72.17	873.	0.	.4

NOTES:

1. STORAGE EOM EQUALS THE STORAGE IN THE RESERVOIR AT THE END OF THE MONTH.
2. WASTE IS THE NONUSABLE OUTFLOW WASTED OVER THE SPILLWAY.
3. YEARS ARE PROJECTED INTO THE ASSUMED TIME OF PROJECT OPERATION WITH 1980 EQUIVALENT TO THE FIRST YEAR OF PERIOD OF RECORD.
4. CRATER LAKE PRODUCES 106 MILLION KWH/YEAR PRIMARY ENERGY AND 13.9 MILLION KWH/YEAR OF SECONDARY ENERGY WITH BENEFIT OF RULE CURVE OPERATION. SEE PLATES 4 & 5 AND TABLES 8 & 10.

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM, ALASKA

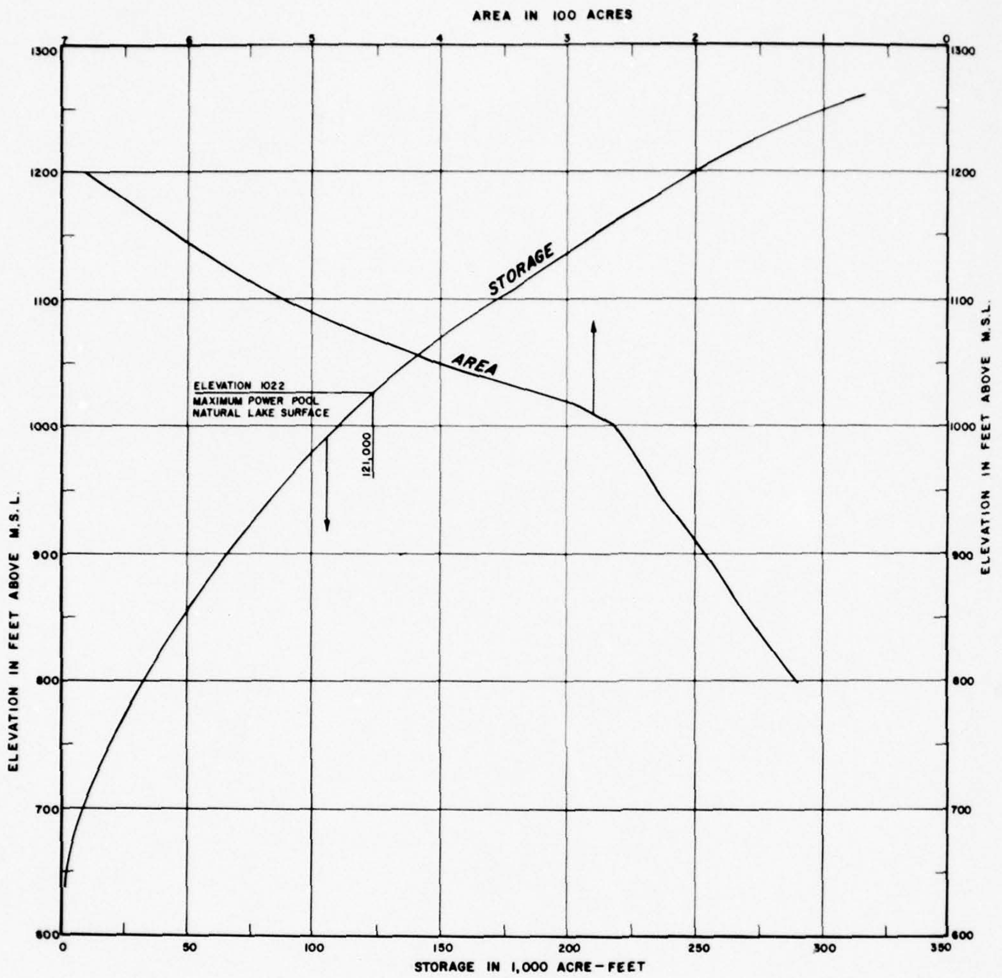
CRATER LAKE

MONTHLY REGULATION COMPUTATIONS

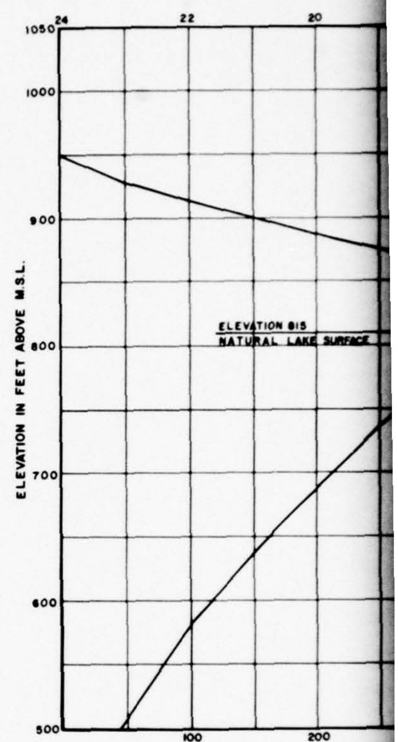
SCALE NONE | DATE AUGUST 1968

FILE NUMBER Q-4-5-113

SHEET 3 OF 3

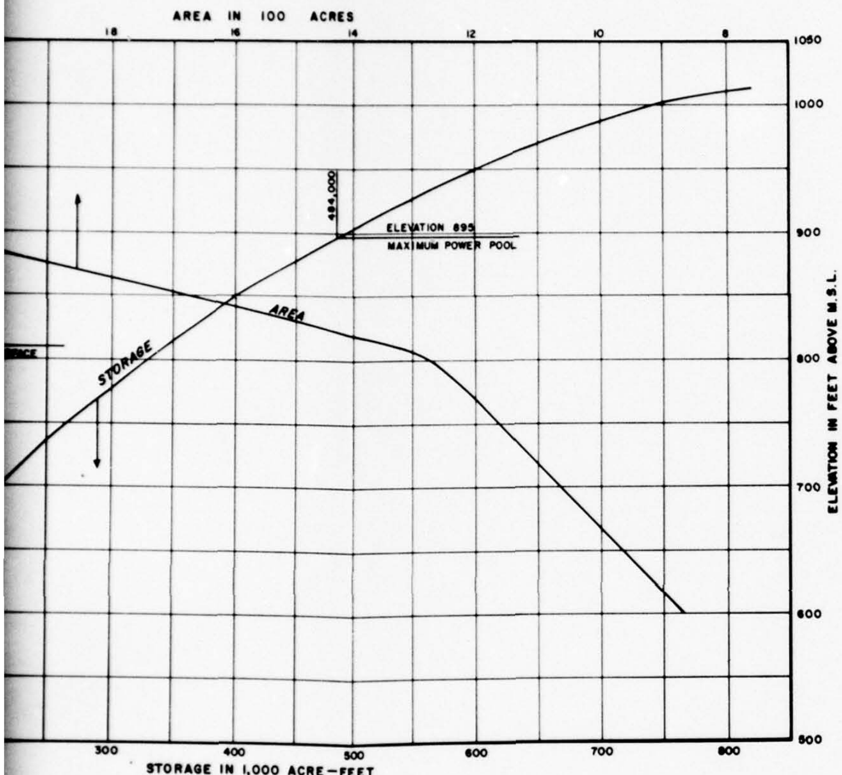


CRATER LAKE



AREA - STORAGE CURVES

U. S. ARMY



LONG LAKE

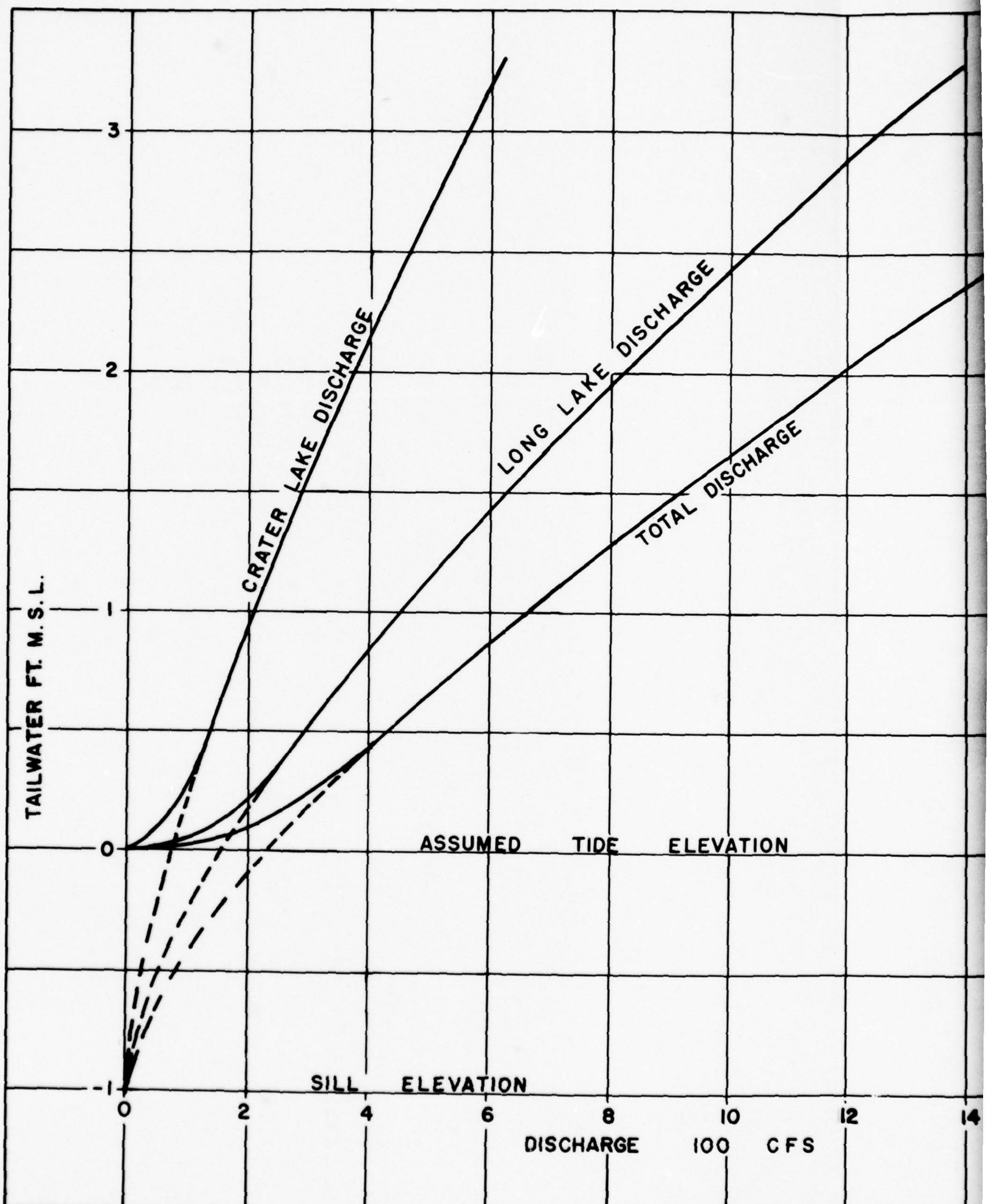
NOTES:

1. The AREA-STORAGE curves are taken from House Document No. 40, 87th. Congress, 1st. Session. Updated with recent survey data.

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
AREA STORAGE CURVES

DESIGNED:	
DRAWN: R.H.	
TRACED:	
CHECKED:	
PREPARED:	
SUPERVISED:	APPROVED:
SUBMITTED:	SCALE AS SHOWN / DATE 31 JULY 1968
RECOMMENDED:	FILE NUMBER Q-4-5-113 / SHEET 1 OF 1



TAILWATER FT. M. S. L.
3
2
1
0
-1
CRATER LAKE DISCHARGE
LONG LAKE DISCHARGE
TOTAL DISCHARGE
ASSUMED TIDE ELEVATION
SILL ELEVATION
0
2
4
6
8
10
12
14
DISCHARGE 100 CFS

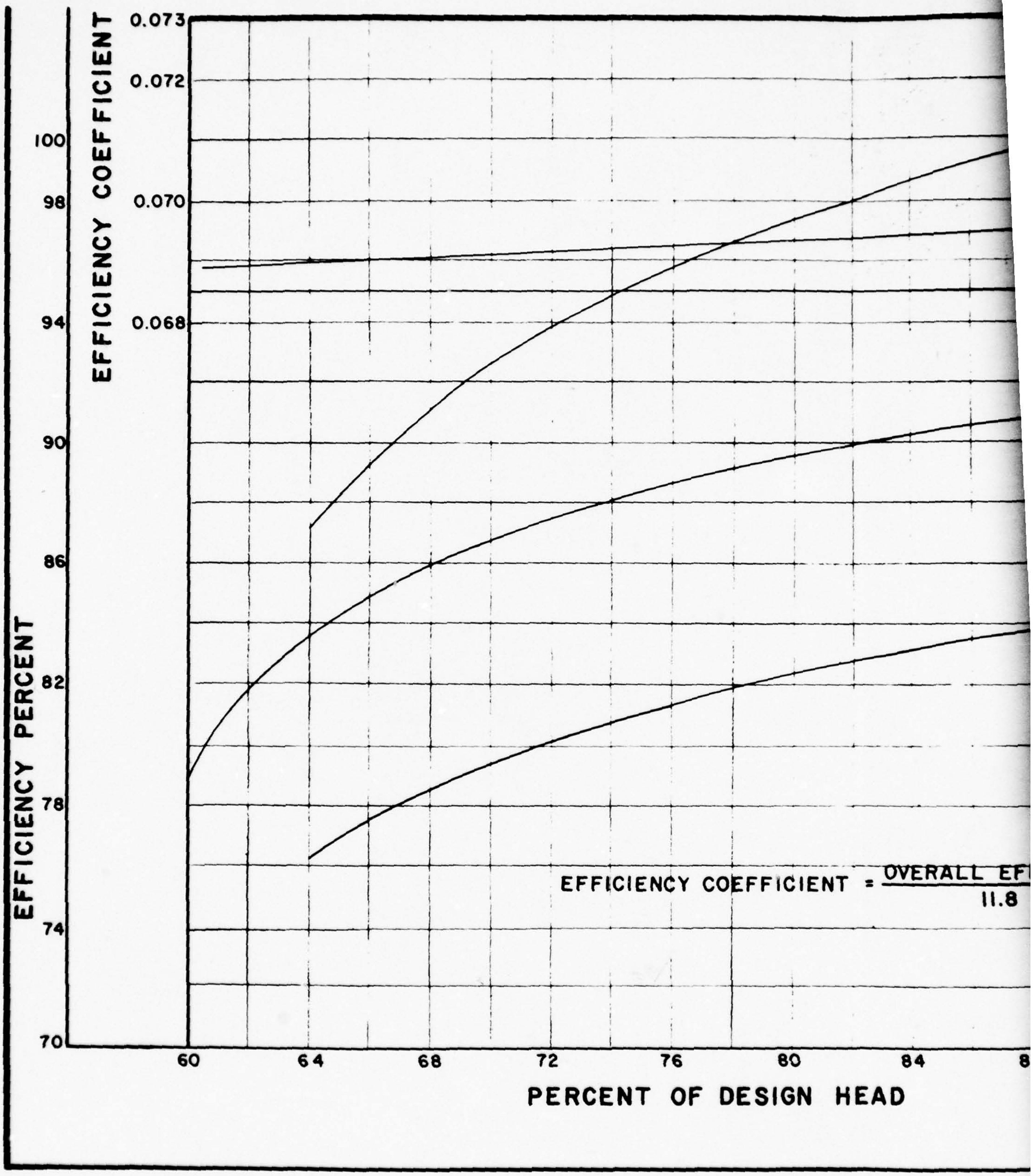
1

NOTES:

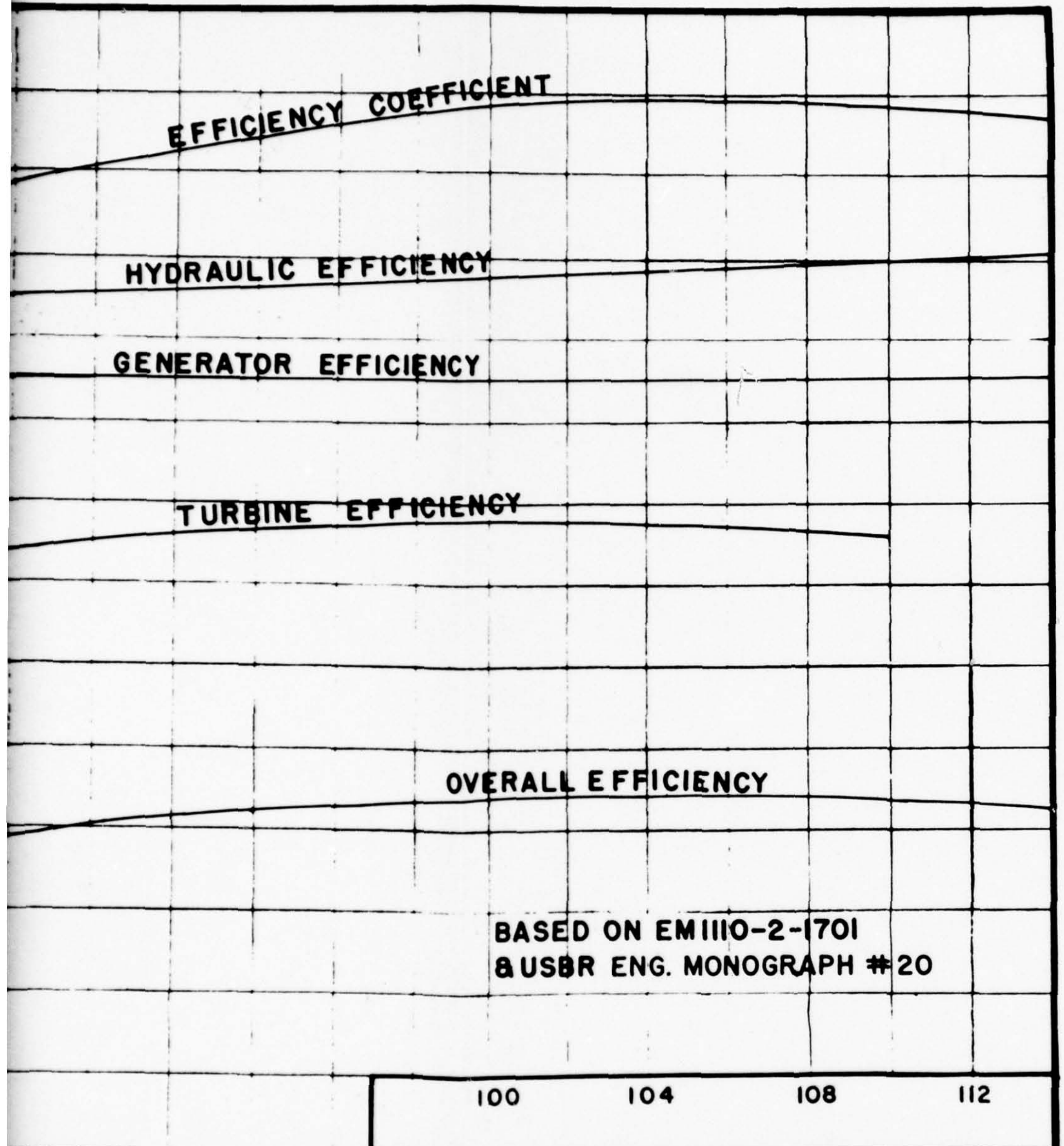
1. Assumed sill elevation = - 1.0 MSL.
2. Assumed sill width = 76 Feet.
3. Rating curve based upon $Q = 3LH^{3/2}$.
4. Assumed discharge balanced in proportion to ave. annual inflow.
5. Assumed tide at 0.0 .

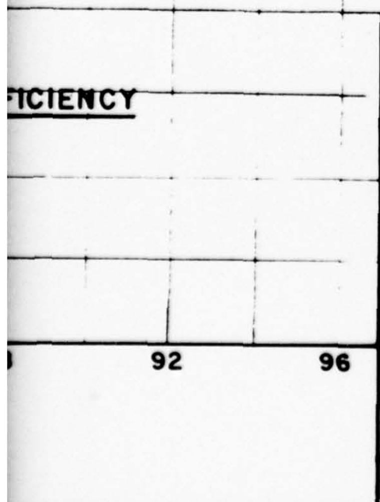
U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED	SNETTISHAM PROJECT, ALASKA
DRAWN	
TRACED	TAILWATER RATING FOR LONG & CRATER LAKES
CHECKED	
PREPARED	
SUPERVISED: CHIEF, POWER INVESTIGATIONS SECTION	APPROVED: COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: CHIEF, PLANNING AND REPORTS BR.	SCALE NONE — DATE 31 JULY '65
RECOMMENDED: CHIEF, ENGINEERING DIVISION	DRAWING NUMBER Q-4-5-113 — SHEET OF


EFFICIENCY COEFFICIENT
EFFICIENCY PERCENT
0.073
0.072
0.070
0.068
100
98
94
90
86
82
78
74
70
60
64
68
72
76
80
84
8
PERCENT OF DESIGN HEAD
EFFICIENCY COEFFICIENT = OVERALL EF
11.8

1





U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA

FIRST STAGE DEVELOPMENT

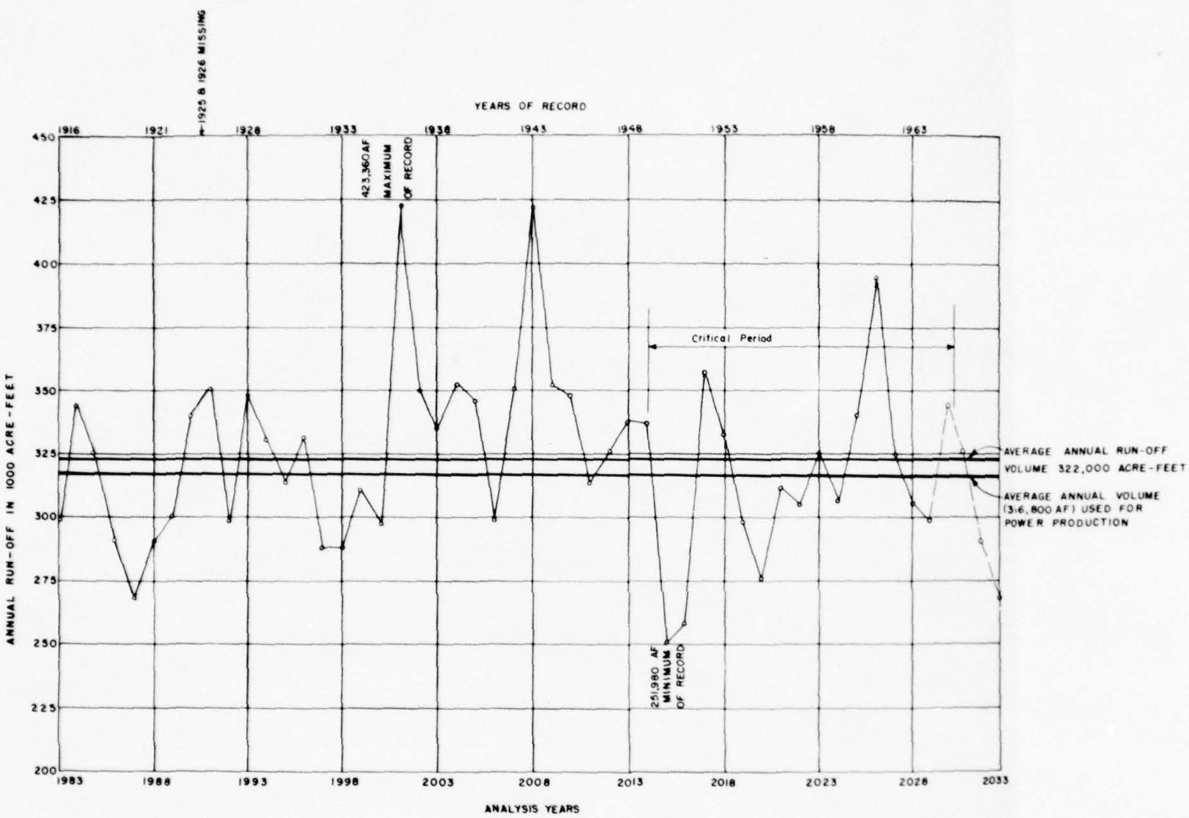
PLANT EFFICIENCIES

DESIGNED	MDW
DRAWN	
TRACED	R.M.D.
CHECKED	MDW
PREPARED	
CHIEF	

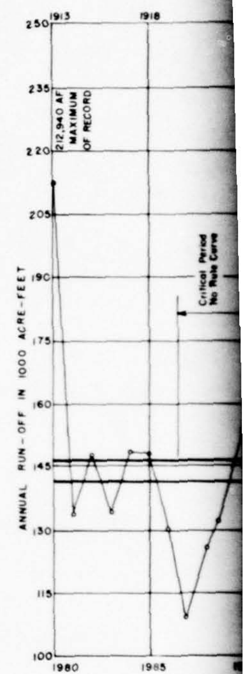
SUPERVISED M. D. Wade Jr. CHIEF, POWER INVESTIGATIONS SECTION	APPROVED Clare T. Farley COLONEL, CE, DISTRICT ENGINEER
SUBMITTED George H. Hould CHIEF, PLANNING AND REPORTS BR.	SCALE NONE — DATE 31 Oct 64
RECOMMENDED Warren George CHIEF, ENGINEERING DIVISION	DRAWING NUMBER Q-4-5-113 SHEET OF

DESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 17

2



LONG LAKE



NOTES 1. Years shown are projected into the assumed time of project operation with 1983 or
equivalent to the first year of period of record.

2. Years connected with dashed lines were repeated from first of period of record to
complete 50 year analysis.

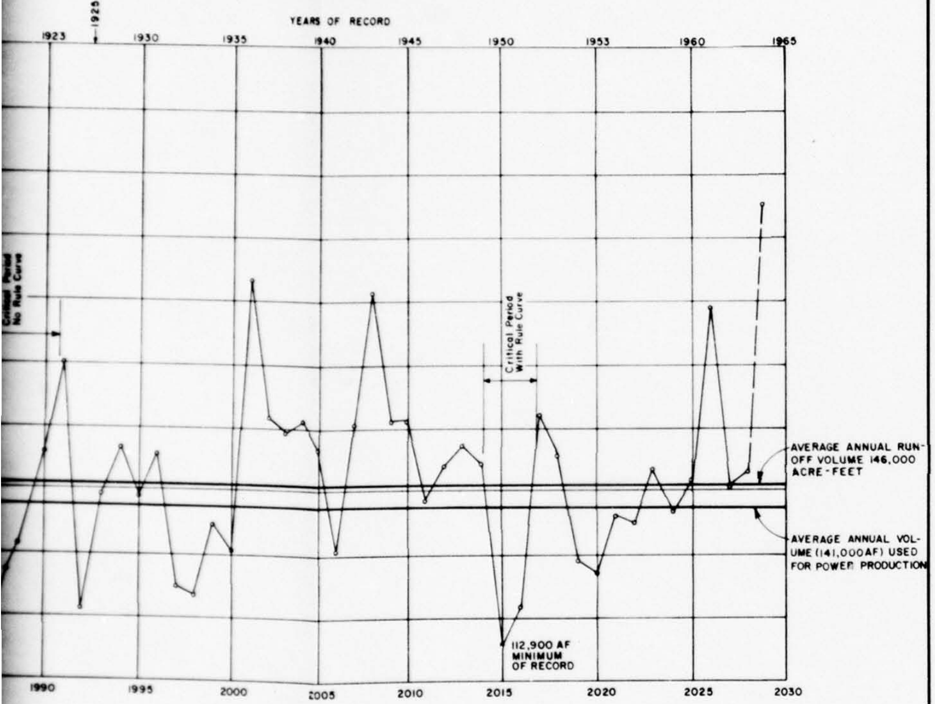
3. Power Production.

(1) Long Lake produces 22.5 million KWH/year primary energy and 9.8 million KWH/
of secondary energy without benefit of rule curve operation. See plates 2 & 3 and
6 & 7

(2) Crater Lake produces 10.6 million KWH/year primary energy and 13.9 million KWH/
of secondary energy with rule curve operation. See plates 4 & 5 and tables 8 &

U. S. ARMY

	PERIOD OF RECORD	PERIOD OF ANALYSIS
LONG LAKE	1916 - 1963	1983 - 2032 INCL.
CRATER LAKE	1913 - 1963	1980 - 2029 INCL.



CRATER LAKE

l or 1980
d to
WH/year
and tables
WH/year
& 9

1	20-6-65	MINOR REV. & UPDATING	M.D.W.
REV	DATE	DESCRIPTION	BY

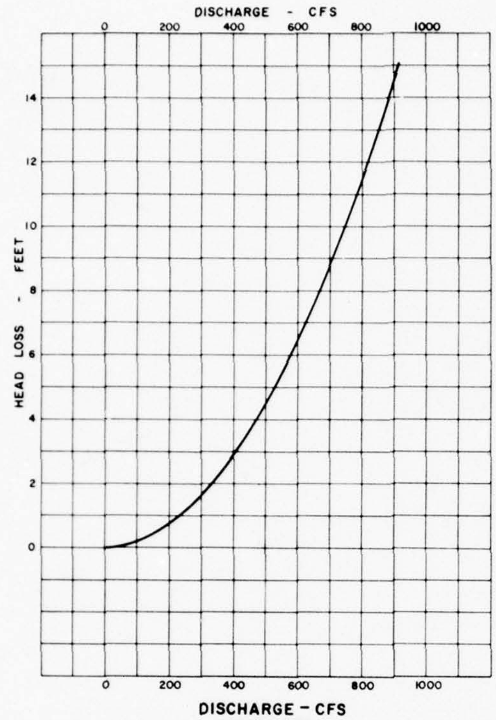
U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: EA
DRAWN: S.R. ANDERSON
TRACED:
CHECKED: GOS
PREPARED: GOS

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
ANNUAL RUN-OFF VOLUME

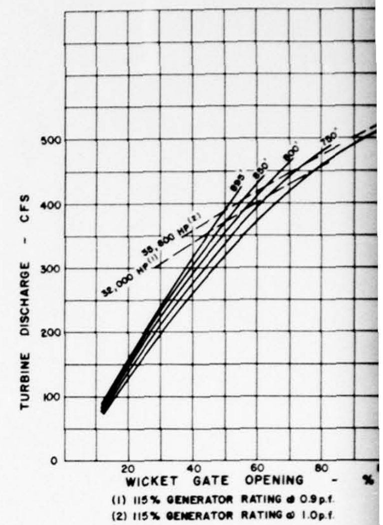
SUPERVISED: M. D. Wade Jr. — CHIEF, POWER INVESTIGATIONS SECTION
SUBMITTED: George ... — CHIEF, PLANNING AND REPORTS BRANCH
RECOMMENDED: Warren George — CHIEF, ENGINEERING DIVISION
APPROVED: ... — COLONEL, CE, DISTRICT ENGINEER
SCALE: AS SHOWN
DATE: 31 JULY 1965
FILE NUMBER: Q-4-5-113
SHEET 1 OF 1

GN MEMORANDUM NO. 7 APPENDIX A PLATE NO. 18

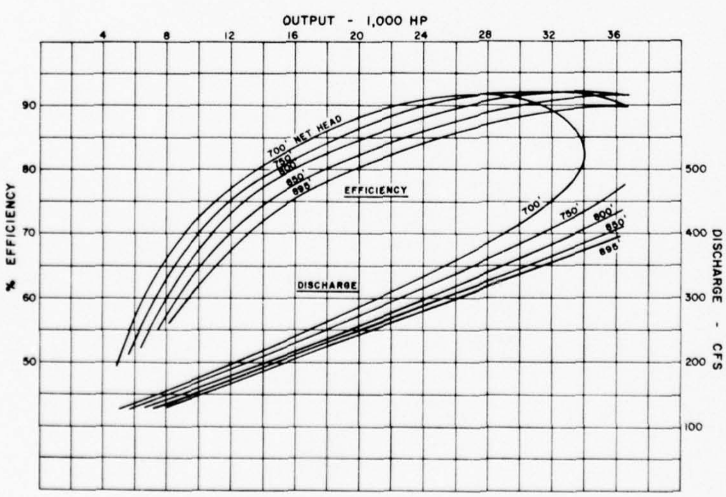


HEAD LOSS

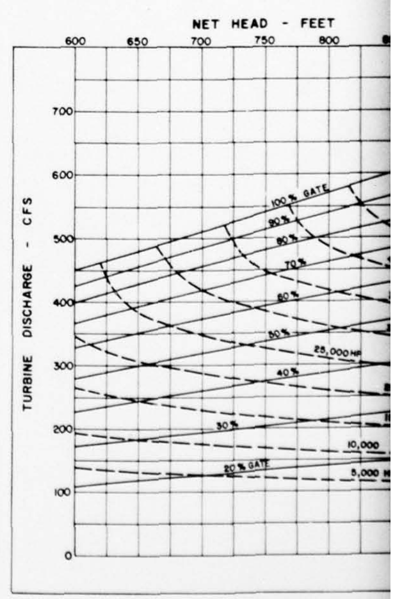
FOREBAY TO UNIT ℄



DISCHARGE VS. GATE OPENING



OUTPUT VS. EFFICIENCY & DISCHARGE



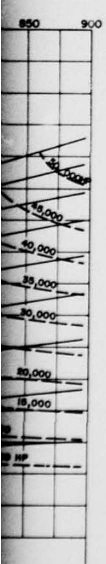
HEAD VS. DISCHARGE

EXPECTED PERFORMANCE

LONG LAKE FRANCIS TURBINES

32,000 HP - 706' NET HEAD - 514 RPM

U. S. ARMY



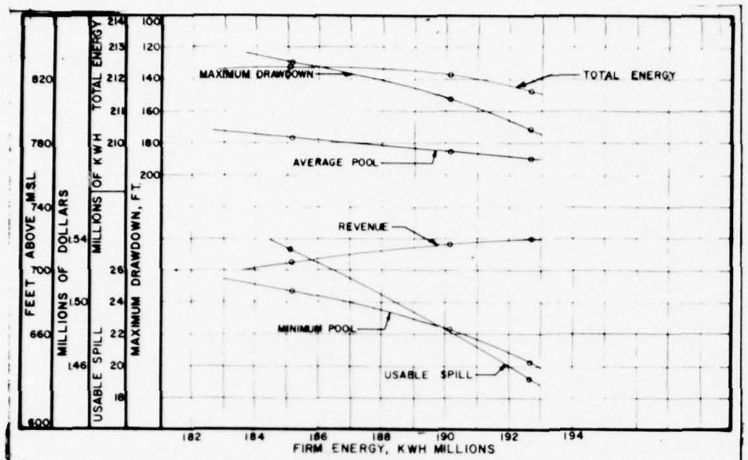
NOTE:
Curves were furnished by Hydro Electric Design Branch, North Pacific Division.

REVISION	DATE	DESCRIPTION	BY

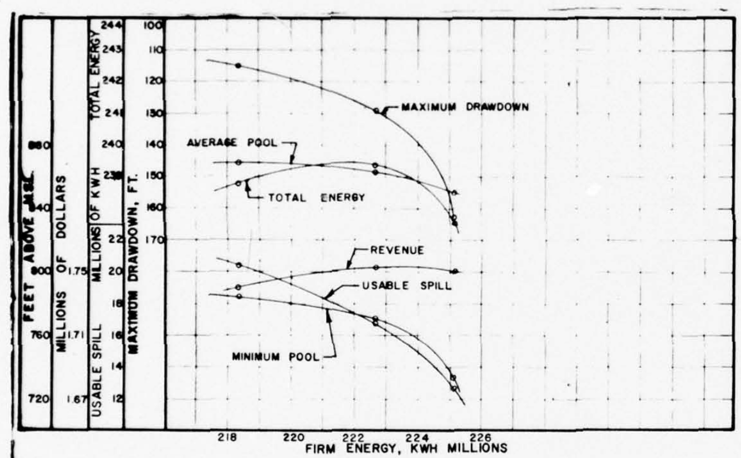
U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:	SNETTISHAM PROJECT, ALASKA
DRAWN:	FIRST STAGE DEVELOPMENT
TRACED: L. NUZZOLESE	EXPECTED
CHECKED:	UNIT PERFORMANCE CURVES
PREPARED:	

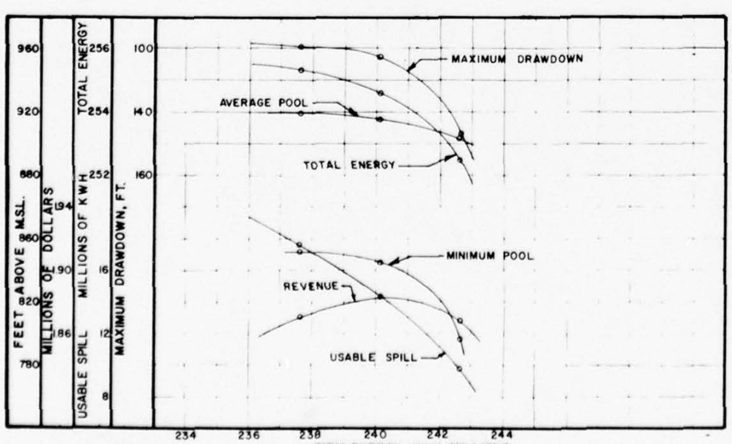
SUPERVISED: CHIEF, POWER INVESTIGATIONS SECTION	APPROVED: COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: CHIEF, PLANNING AND REPORTS	SCALE NONE DATE
RECOMMENDED: CHIEF, ENGINEERING DIVISION	FILE NUMBER Q-4-5-113 SHEET 1 OF 1



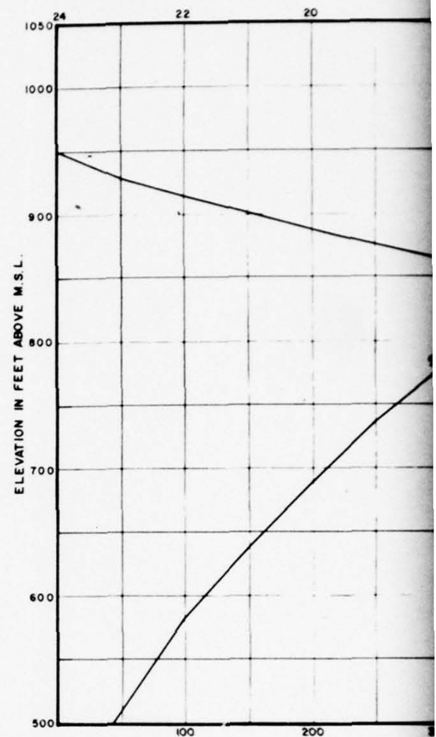
MAXIMUM POOL 815

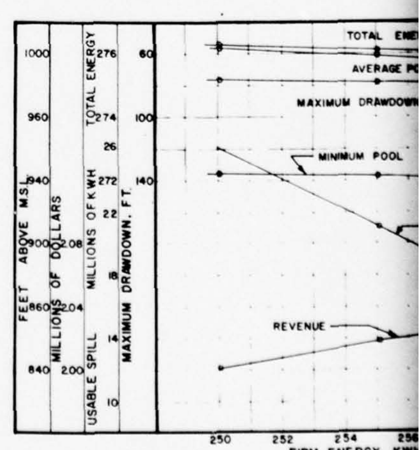


MAXIMUM POOL 900



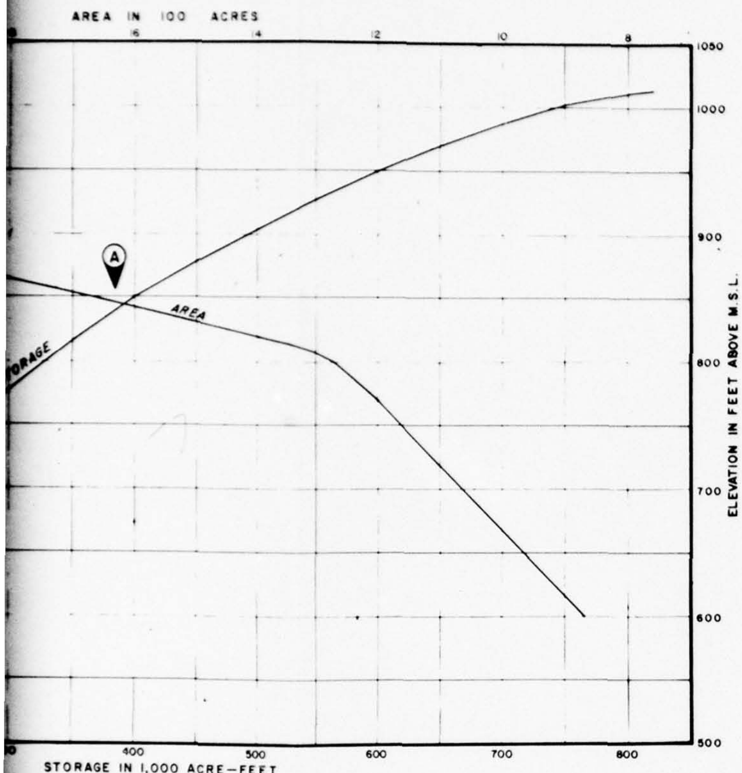
MAXIMUM POOL 950





MAXIMUM POO

U. S. ARMY



LONG LAKE

NOTES:

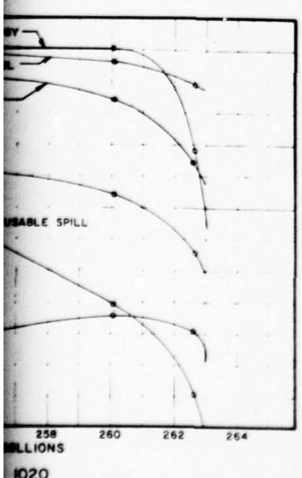
1. The AREA-STORAGE curves are taken from House Document No. 40, 87th Congress, 1st Session. Updated with recent survey data

The USABLE SPILL (secondary energy) indicates energy that [illegible] be produced from water beyond storage capacity but not beyond machine capacity.

The REVENUE curve is based on a mill rate of 7.5 M/KWH for primary and 5 M/KWH (from project document) for secondary energy and are to be used for comparison purposes only.

The TOTAL ENERGY curve is composite of total energy demand imposed on the project plus secondary energy.

MAXIMUM DRAWDOWN is shown in feet and minimum pool is shown as an elevation in feet.



REV.	DATE	DESCRIPTION	BY
A	July 1965	Area - Storage curves updated	

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED | DRAWN | TRACED | CHECKED | PREPARED

SNETTISHAM PROJECT, ALASKA

PRELIMINARY STUDIES

LONG LAKE

AREA-STORAGE & SUMMARY CURVES

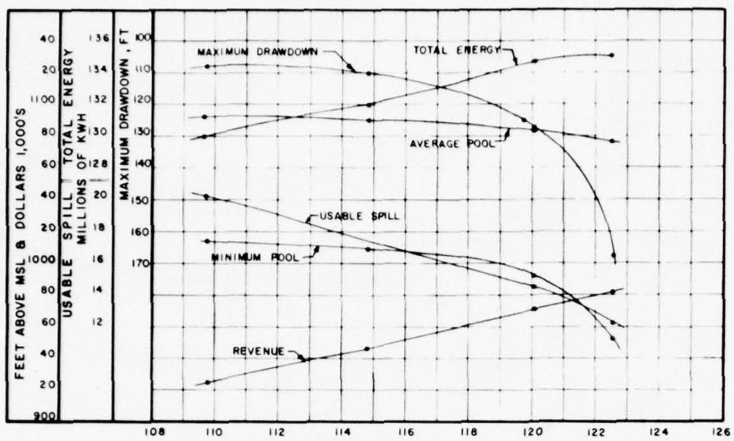
SUPERVISED — CHIEF, POWER INVESTIGATIONS SECTION
SUBMITTED — CHIEF, PLANNING AND REPORTS BRANCH
RECOMMENDED — CHIEF, ENGINEERING DIVISION

APPROVED — COLONEL, CE, DISTRICT ENGINEER

SCALE: AS SHOWN | DATE: 31 Oct. 64

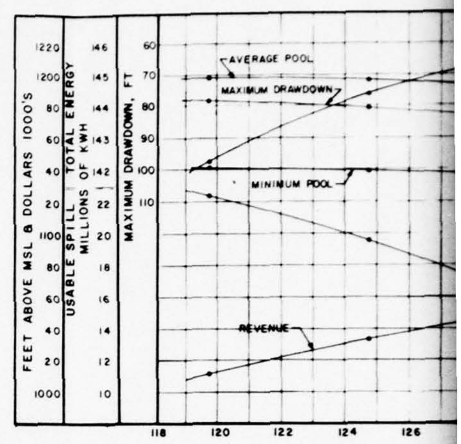
FILE NUMBER: Q-4-5-113

SHEET OF



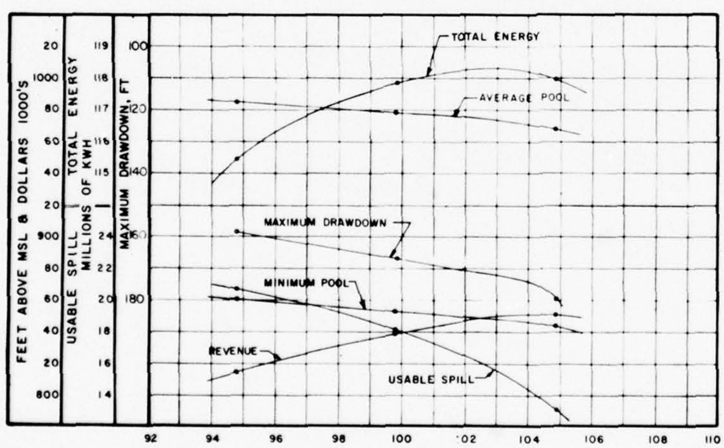
FIRM ENERGY, KWH MILLIONS

MAXIMUM POOL 1120



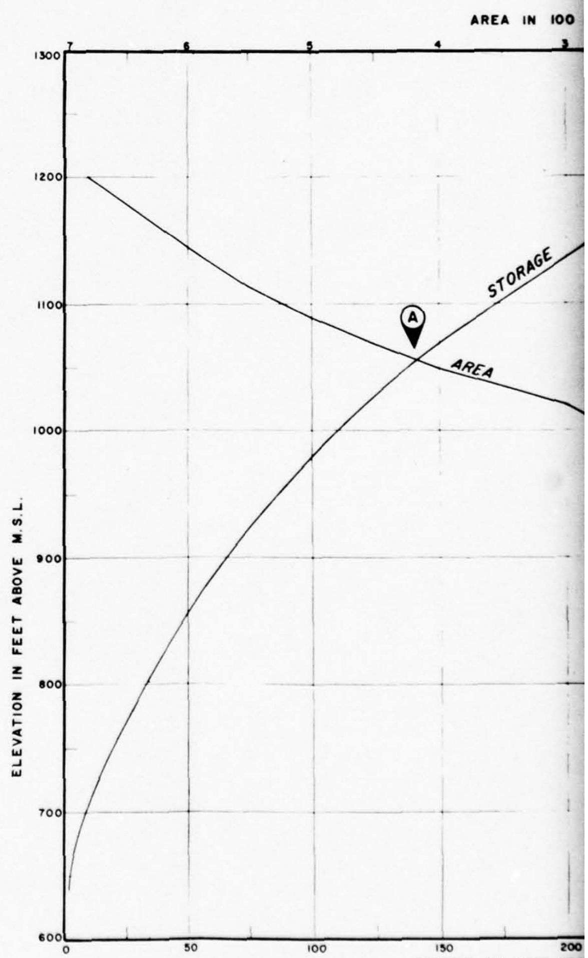
FIRM ENERGY, KWH

MAXIMUM POOL



FIRM ENERGY, KWH MILLIONS

MAXIMUM POOL 1020

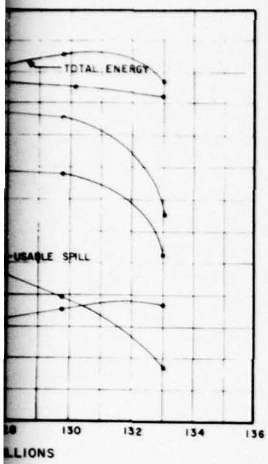


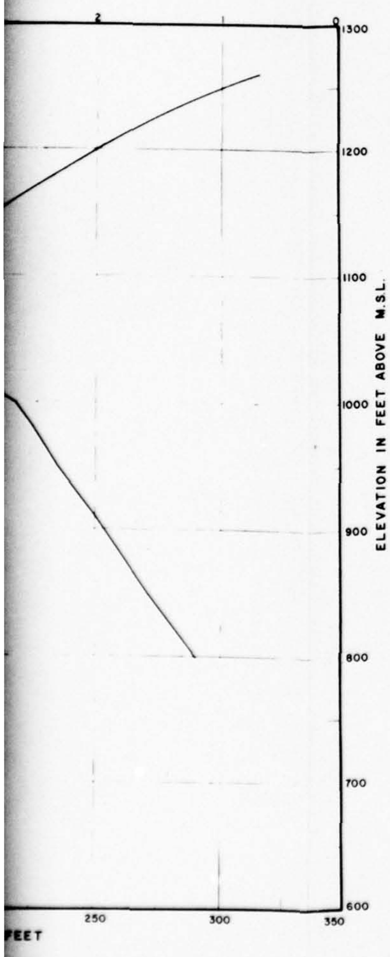
STORAGE IN 1,000 ACR

CRATER LA

AREA – STORAGE

U. S. ARMY





NOTES:

1. The AREA-STORAGE curves are taken from House Document No. 40, 87th Congress, 1st Session. Updated with recent survey data.

The USABLE SPILL (secondary energy) indicates energy that could be produced from water beyond storage capacity but not beyond machine capacity.

The REVENUE curve is based on a mill rate of 7.5 M/KWH for primary and 5 M/KWH (from project document) for secondary energy and are to be used for comparison purposes only.

The TOTAL ENERGY curve is composite of total energy demand imposed on the project plus secondary energy.

MAXIMUM DRAWDOWN is shown in feet and minimum pool is shown as an elevation in feet.

REV	DATE	DESCRIPTION	BY
A	July 1965	Area - Storage curves updated	[illegible]

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

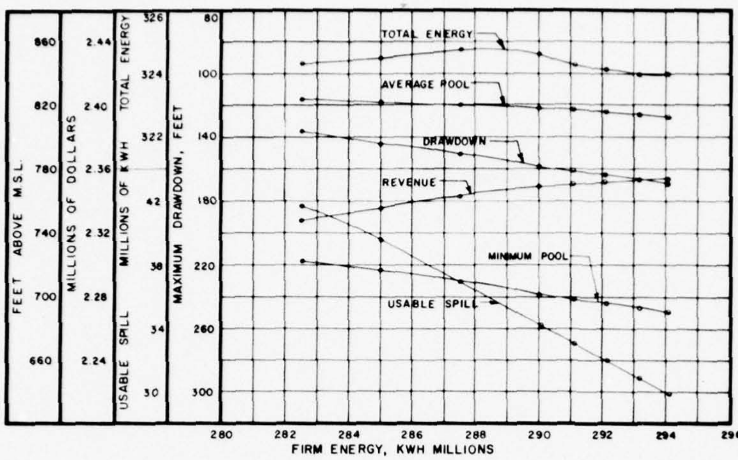
SNETTISHAM PROJECT, ALASKA
PRELIMINARY STUDIES
CRATER LAKE
AREA-STORAGE & SUMMARY CURVES

DESIGNED: [illegible] GGS
DRAWN:
TRACED:
CHECKED: GGS
PREPARED: [illegible]

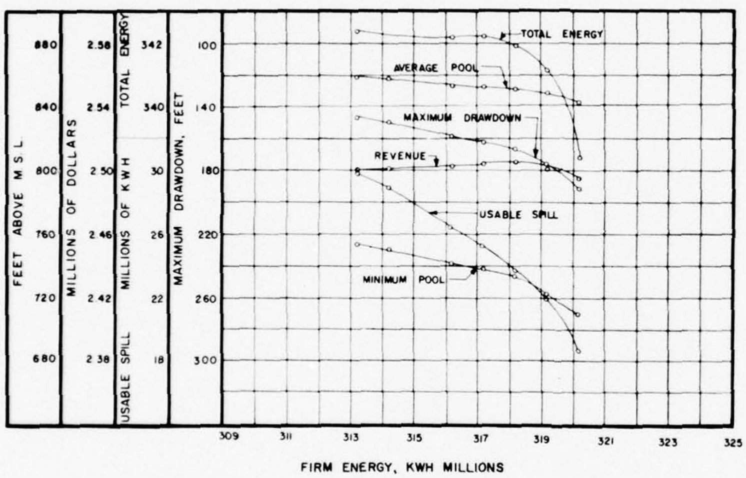
SUPERVISED: [illegible] — CHIEF, POWER INVESTIGATIONS SECTION
SUBMITTED: [illegible] — CHIEF, PLANNING AND REPORTS BRANCH
RECOMMENDED: [illegible] — CHIEF, ENGINEERING DIVISION

APPROVED: [illegible] — COLONEL, CE, DISTRICT ENGINEER
SCALE: AS SHOWN
DATE: 31 Oct 64
FILE NUMBER: Q-4-5-113
SHEET OF

2



MAXIMUM POOL 815



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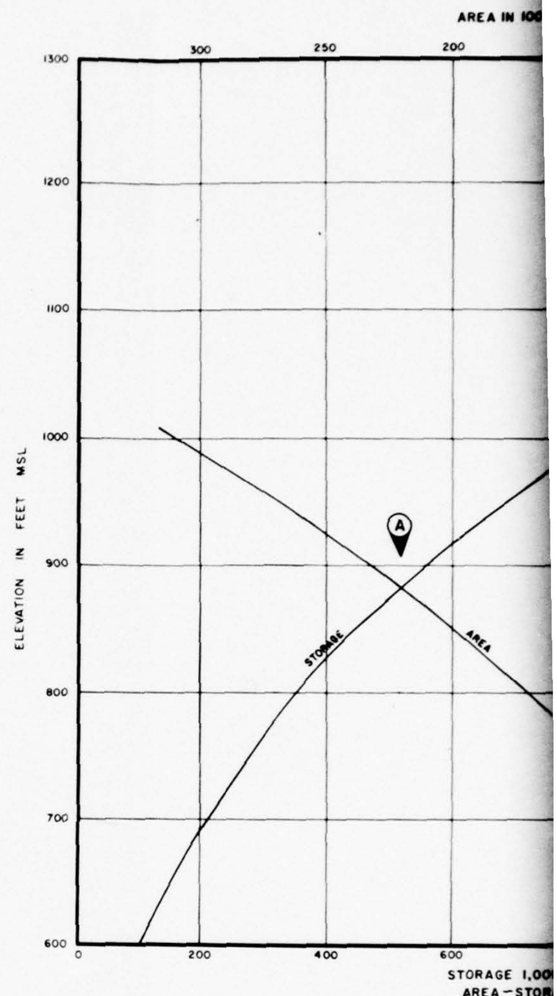

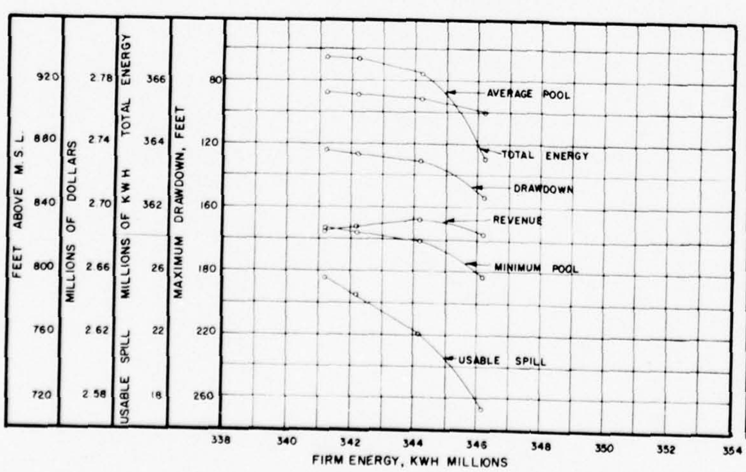

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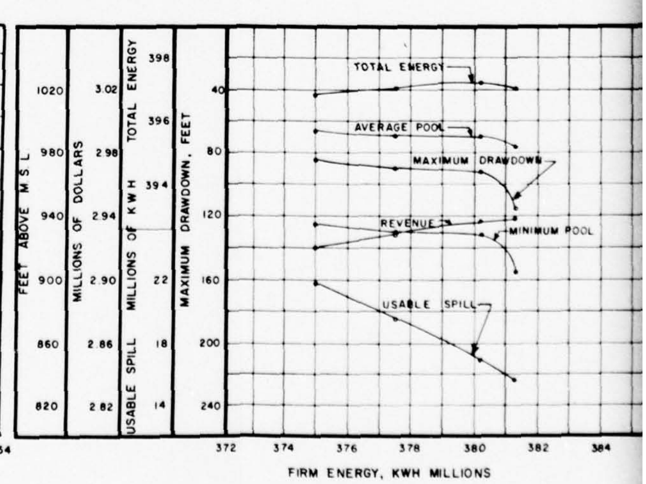
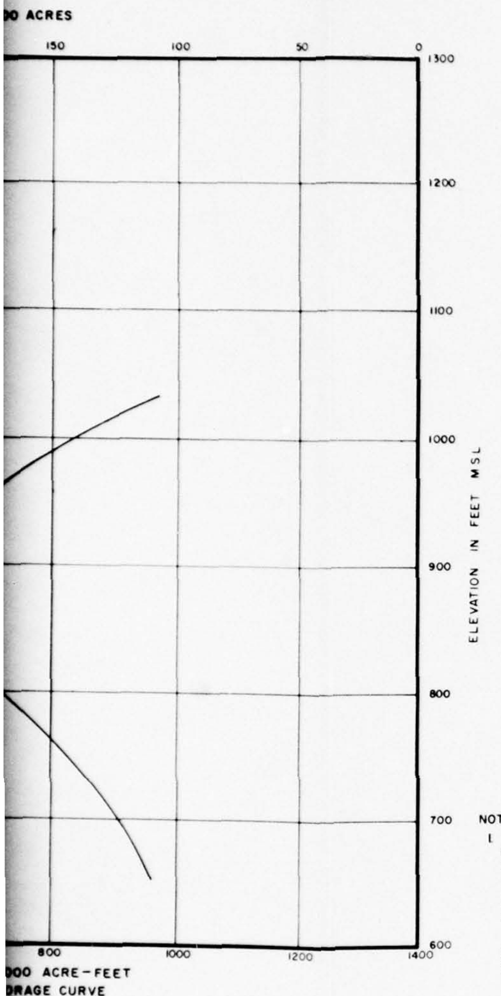


MAXIMUM POOL 1020

U. S. ARMY



NOTES

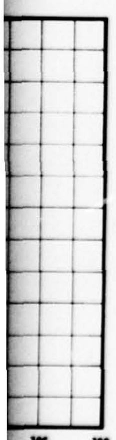
1. The AREA-STORAGE curves are taken from House Document No. 40, 87th Congress, 1st Session. Updated with recent survey data.

The USABLE SPILL (secondary energy) indicates energy that could be produced from water beyond storage capacity but not beyond machine capacity.

The REVENUE curve is based on a mill rate of 7.5 M/KWH for primary and 5 M/KWH (from project document) for secondary energy and are to be used for comparison purposes only.

The TOTAL ENERGY curve is composite of total energy demand imposed on the project plus secondary energy.

MAXIMUM DRAWDOWN is shown in feet and minimum pool is shown as an elevation in feet.



REV	DATE	DESCRIPTION	BY
A	July 1965	Area-Storage curves updated.	

U S ARMY ENGINEER DISTRICT ALASKA
CORPS OF ENGINEERS
ANCHORAGE ALASKA

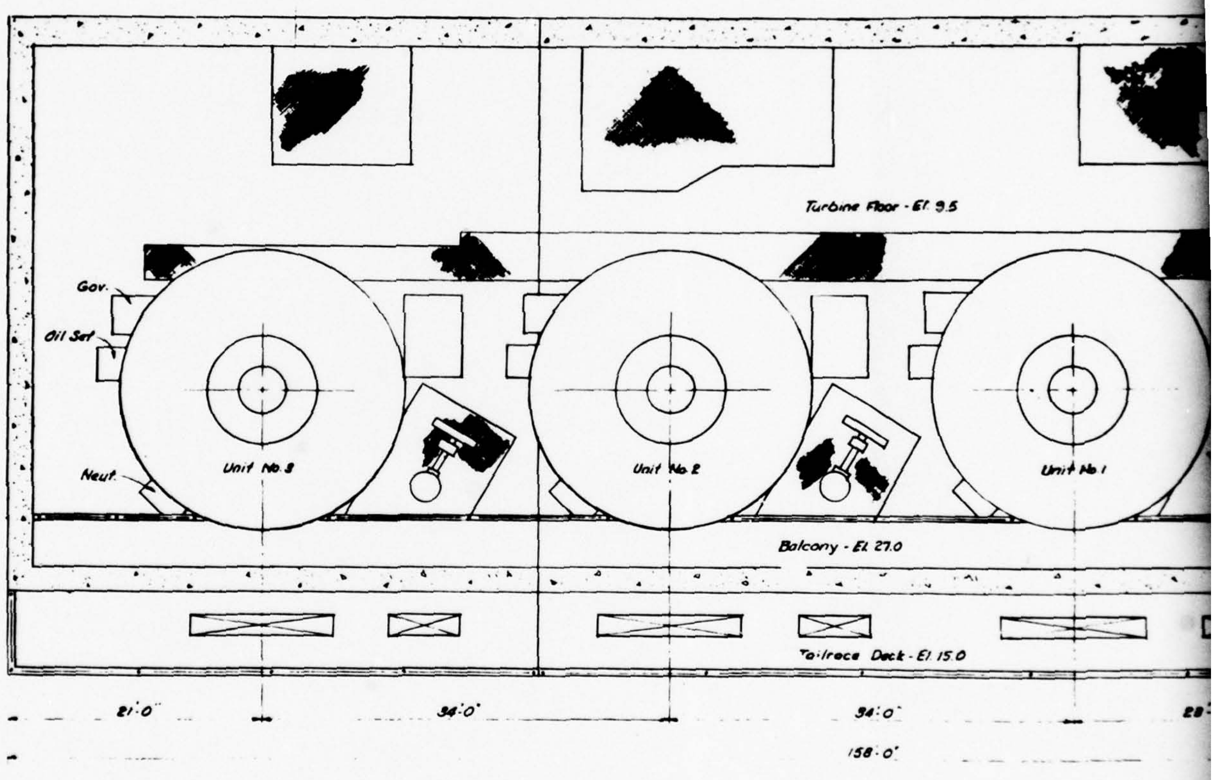
SNETTISHAM PROJECT, ALASKA

PRELIMINARY STUDIES

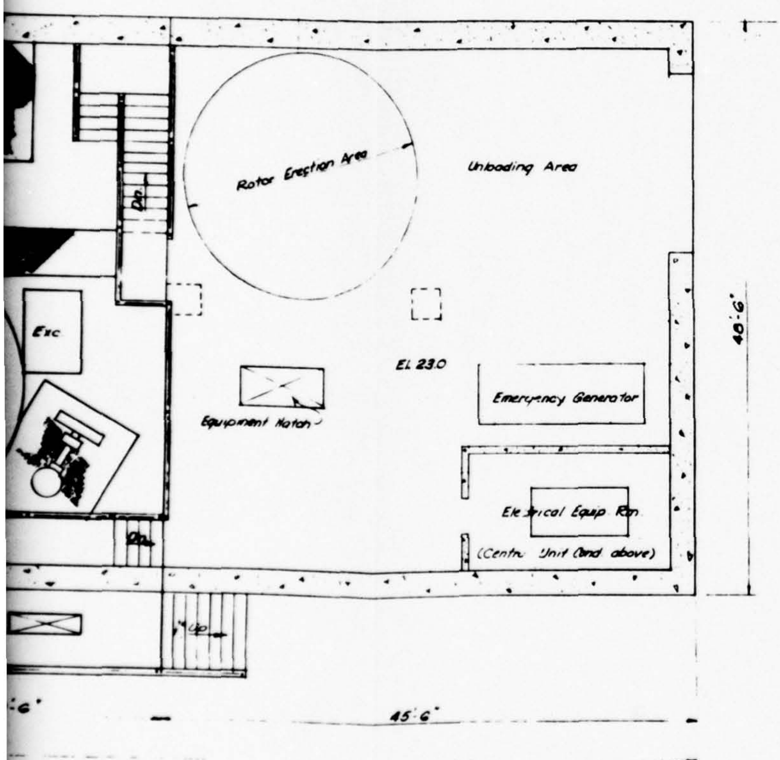
COMBINED LAKES
AREA-STORAGE & SUMMARY CURVES

DESIGNED
DRAWN
TRACED S. R. ANDERSON
CHECKED
PREPARED
SUPERVISED — CHIEF, POWER INVESTIGATIONS SECTION
SUBMITTED — CHIEF, PLANNING AND REPORTS BRANCH
RECOMMENDED — CHIEF, ENGINEERING DIVISION
APPROVED — COLONEL CE DISTRICT ENGINEER
SCALE AS SHOWN
DATE 31 Oct 64
FILE NUMBER Q-4-5-113
SHEET OF

CORPS OF ENGINEERS



U. S. ARMY



1	1 Oct 65	Redrawn	
REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

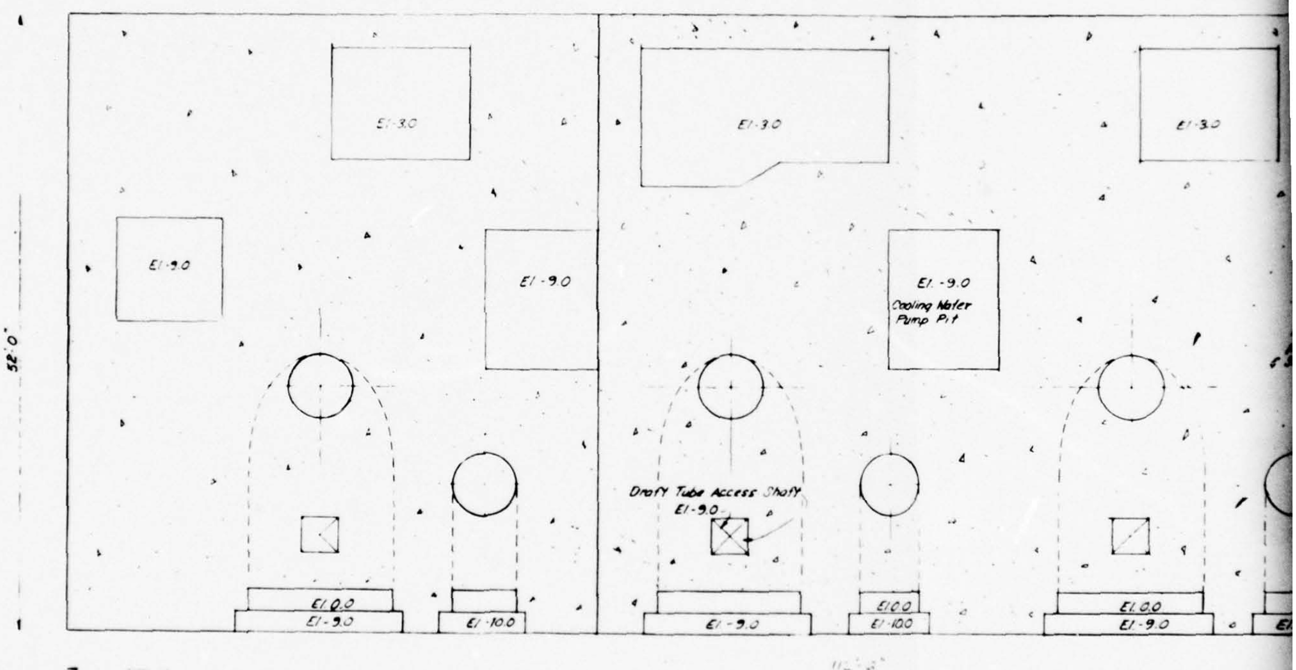
DESIGNED BY KJL
DRAWN BY KJL
CHECKED BY

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
POWERHOUSE
PLAN - EL. 23.0

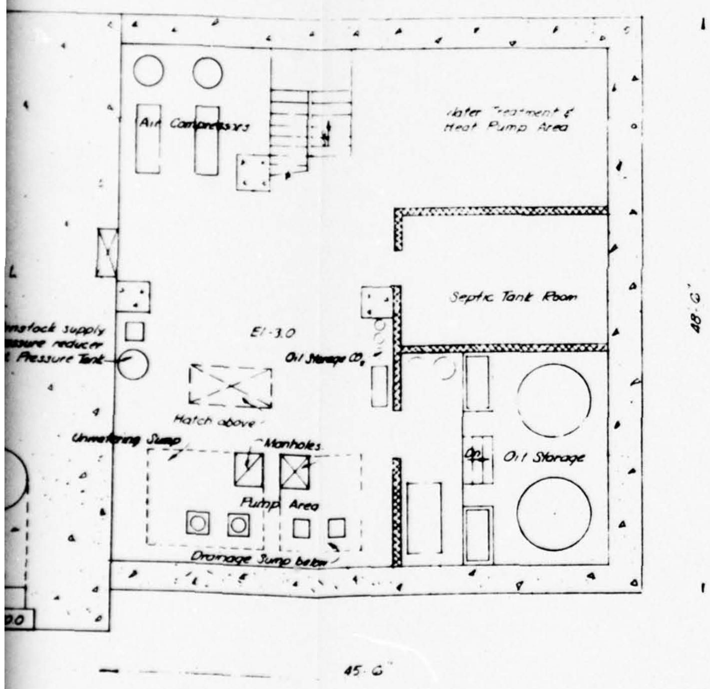
SUBMITTED
APPROVED DATE 1 Oct 1965
SCALE 1/8"=1'-0"
SPEC. NO.
SNP-O-O-O/2

DESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 23

CORPS OF ENGINEERS



U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

DESIGNED BY KJL
DRAWN BY KJL
CHECKED BY

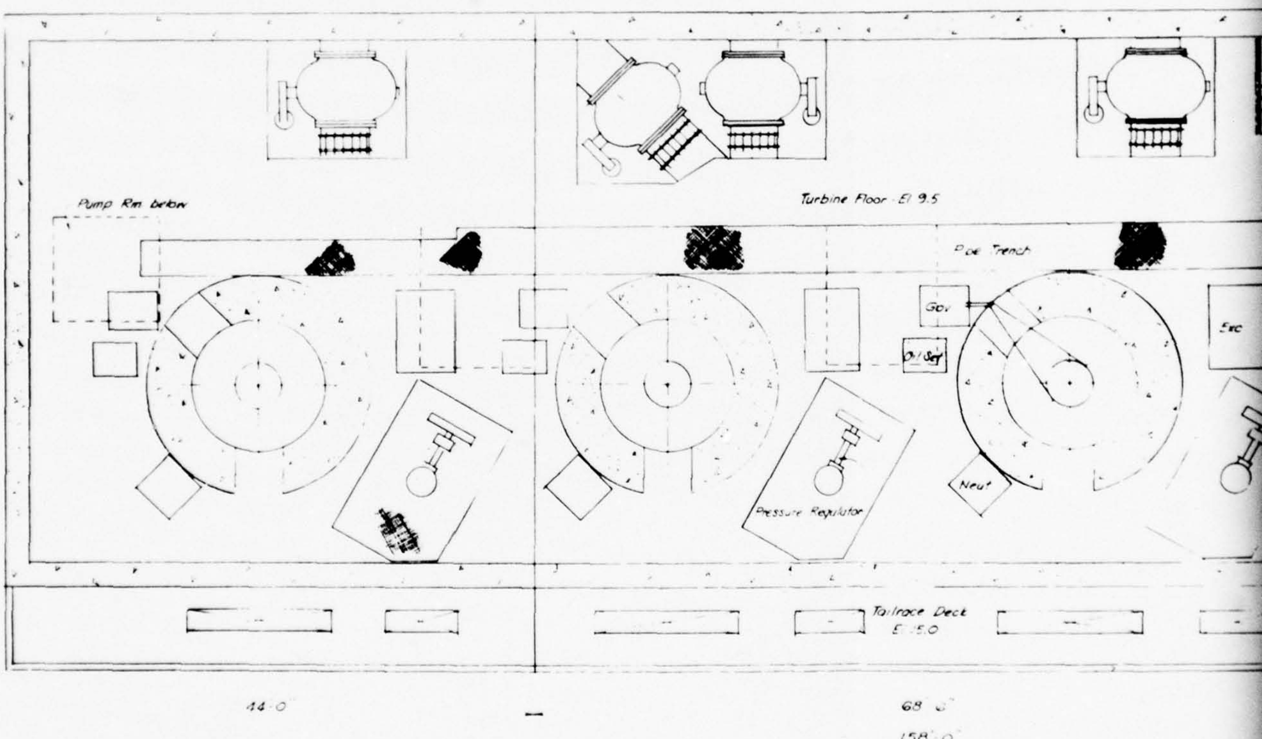
SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
POWERHOUSE
PLAN - EL.-3.0

DATE 1 Oct. 1968
SCALE 1/16"=1'-0"
SPEC. NO.
SNP 0-0-0/11

DESIGN MEMORANDUM NO. 7 APPENDIX A | PLATE 24

2

CORPS OF ENGINEERS



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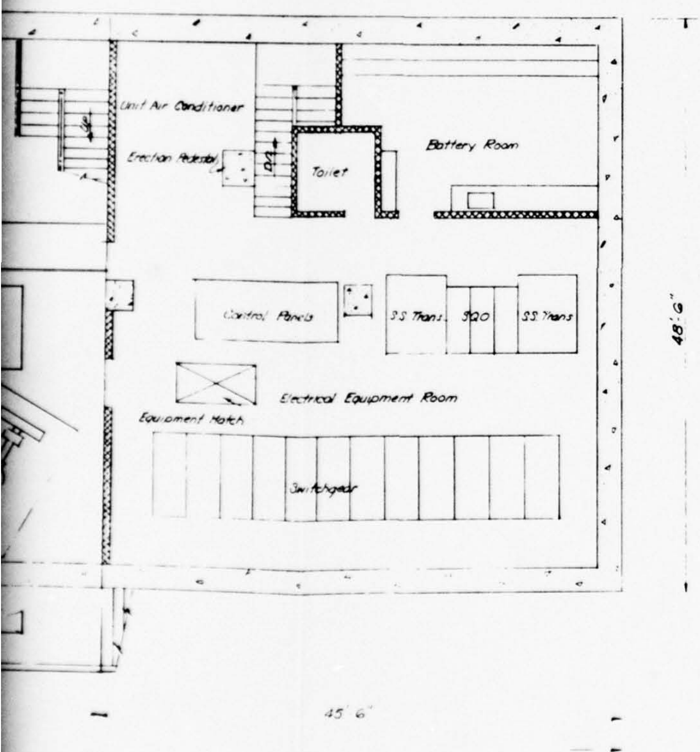


REVISION	DATE	DESCRIPTION	BY
1	1Oct65	Redrawn	

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

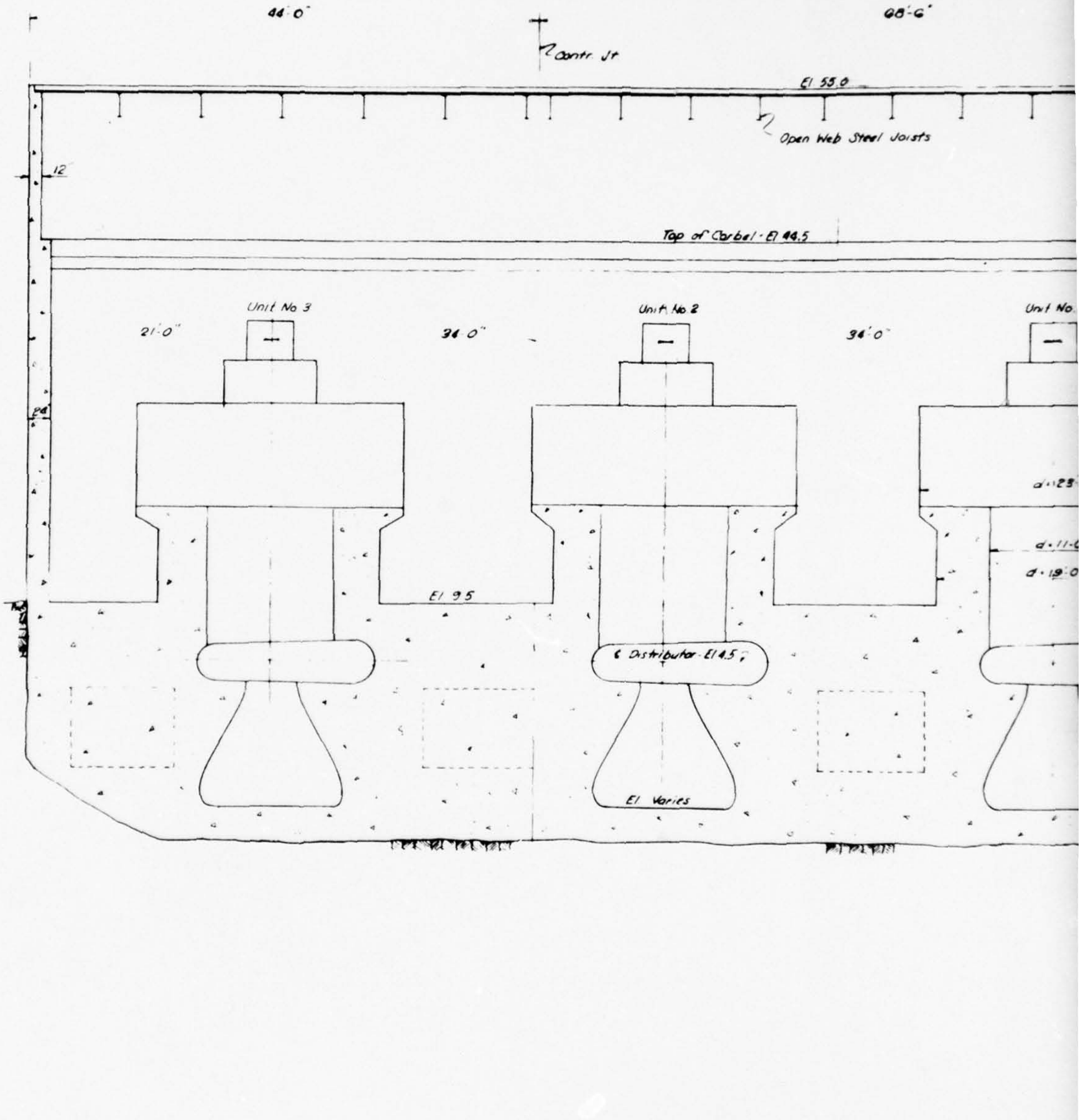
DESIGNED BY KJL
DRAWN BY KJL
CHECKED BY
PREPARED: E. B. Spicer

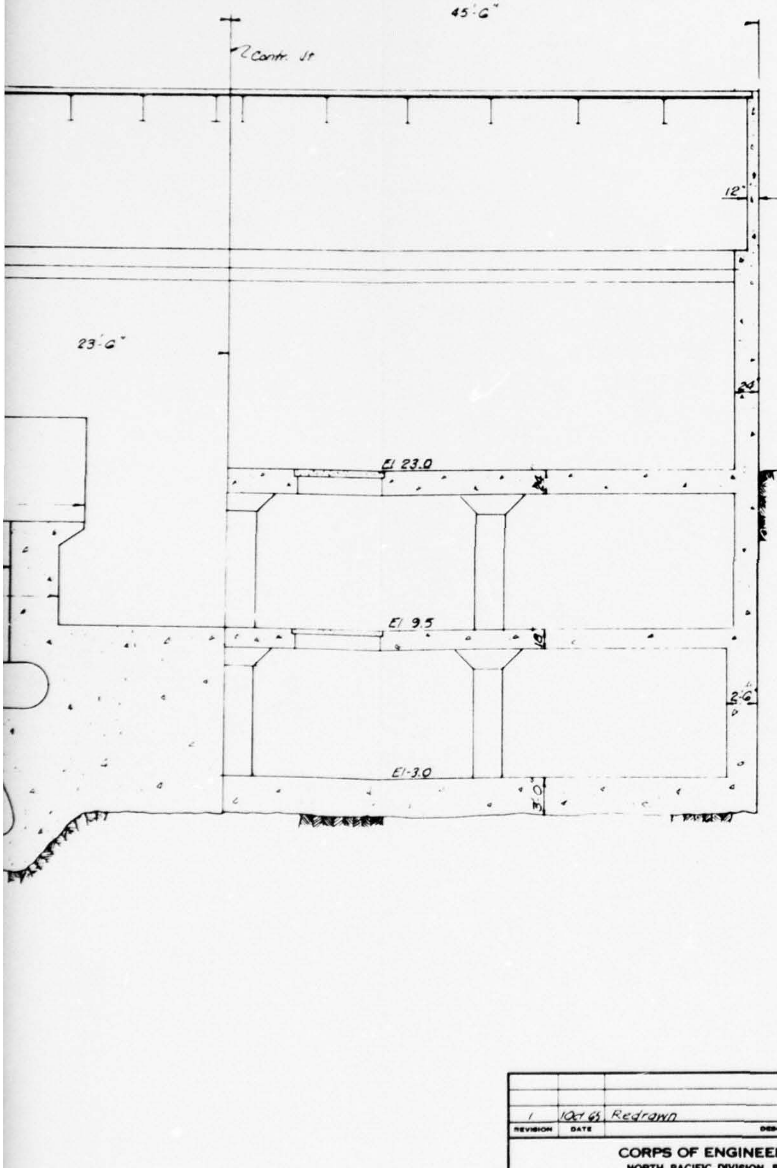
SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
POWERHOUSE
PLAN - EL. 9.5

APPROVED FOR DIV. ENGINEER — DATE 1 Oct. '65
SUBMITTED:
CHIEF HYDRO-ELECTRIC DESIGN BRANCH
SCALE 1/16" = 1'-0" SPEC. NO.
SHEET SNP 0-0-0/3

2

CORPS OF ENGINEERS





REVISION	DATE	DESCRIPTION	BY
1	1 Oct 65	Redrawn	

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

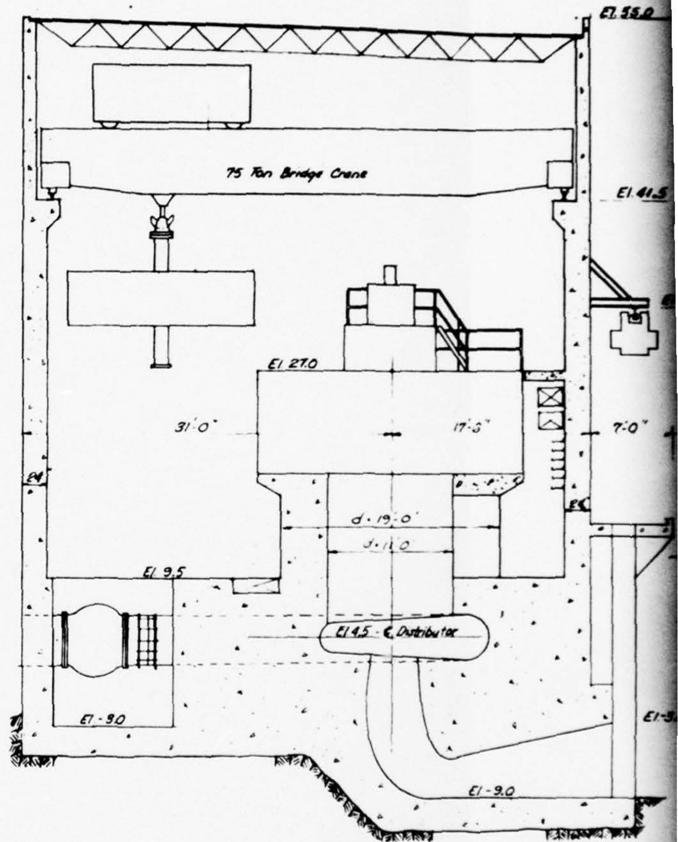
DESIGNED BY KJL
DRAWN BY KJL
CHECKED BY

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
POWERHOUSE
LONGIT. SECTION THRU ℄ UNITS

SCALE 1/8" = 1'-0"
SPEC. NO.
SNP 0-0-0/5

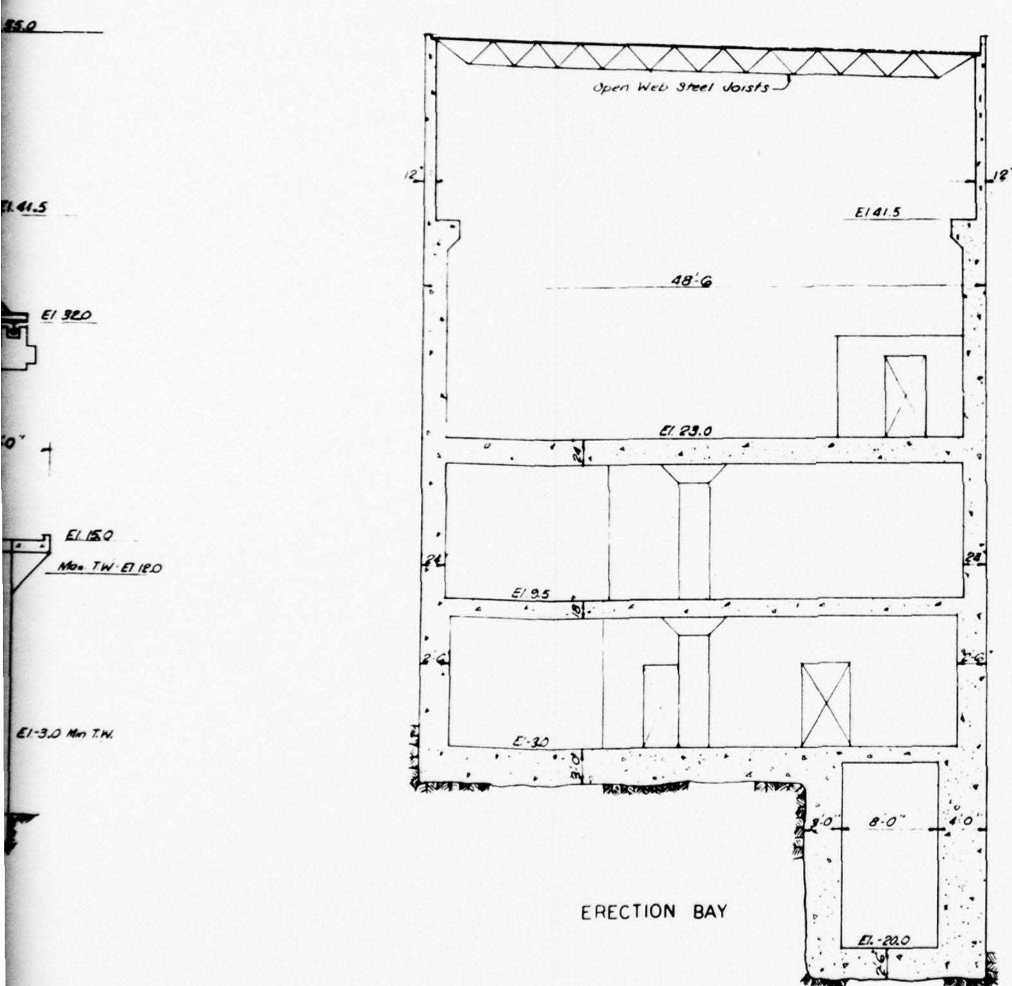
DESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 26

CORPS OF ENGINEERS



MAIN UNIT

U. S. ARMY



ERECTION BAY

REVISION	DATE	DESCRIPTION	BY
1	1 Oct 65	Redrawn	

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

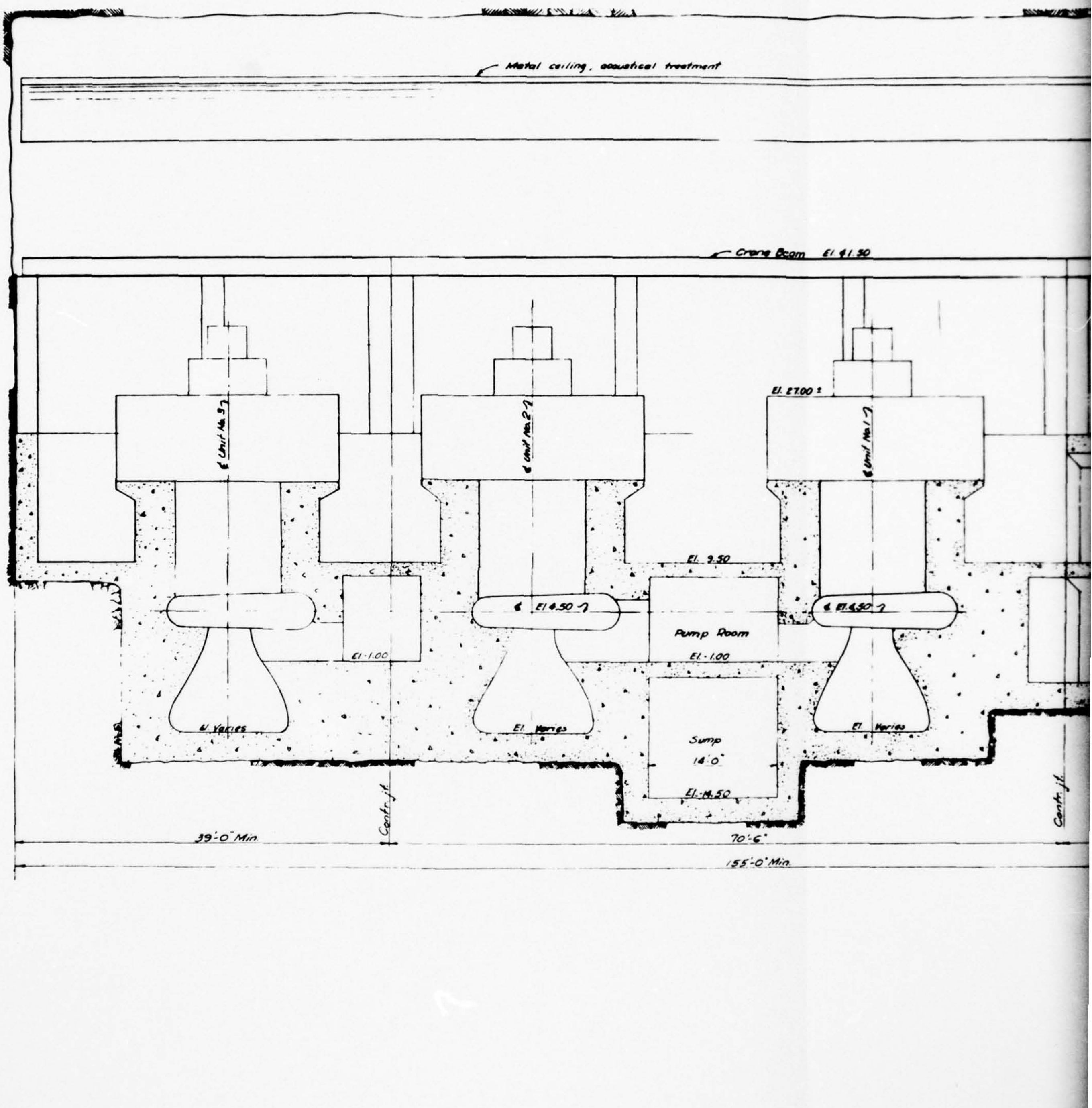
DESIGNED BY KJL
DRAWN BY KJL
CHECKED BY

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
POWERHOUSE
TRANSVERSE SECTIONS

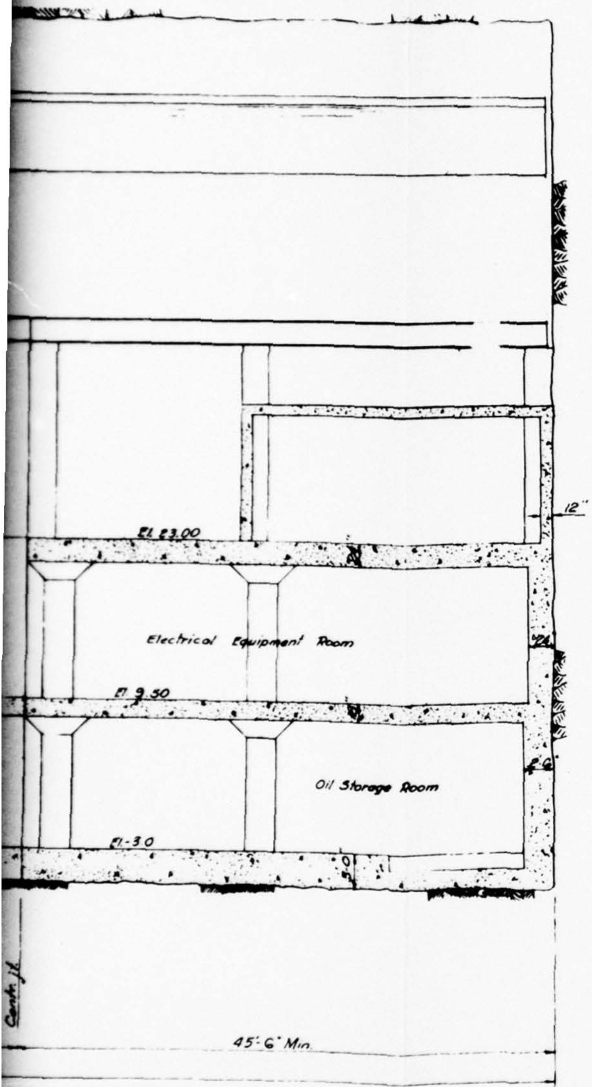
APPROVED FOR DIV. ENGINEER DATE 1 Oct. '65
SCALE 1/16" = 1'-0"
SPEC. NO.
SHEET SNP 0-0-0/4

2

CORPS OF ENGINEERS



U. S. ARMY



Revision	Date	Description	By
1	10Oct65	Increased Erection Bay length	

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

Designed by KVL
Drawn by V.S.
Checked by

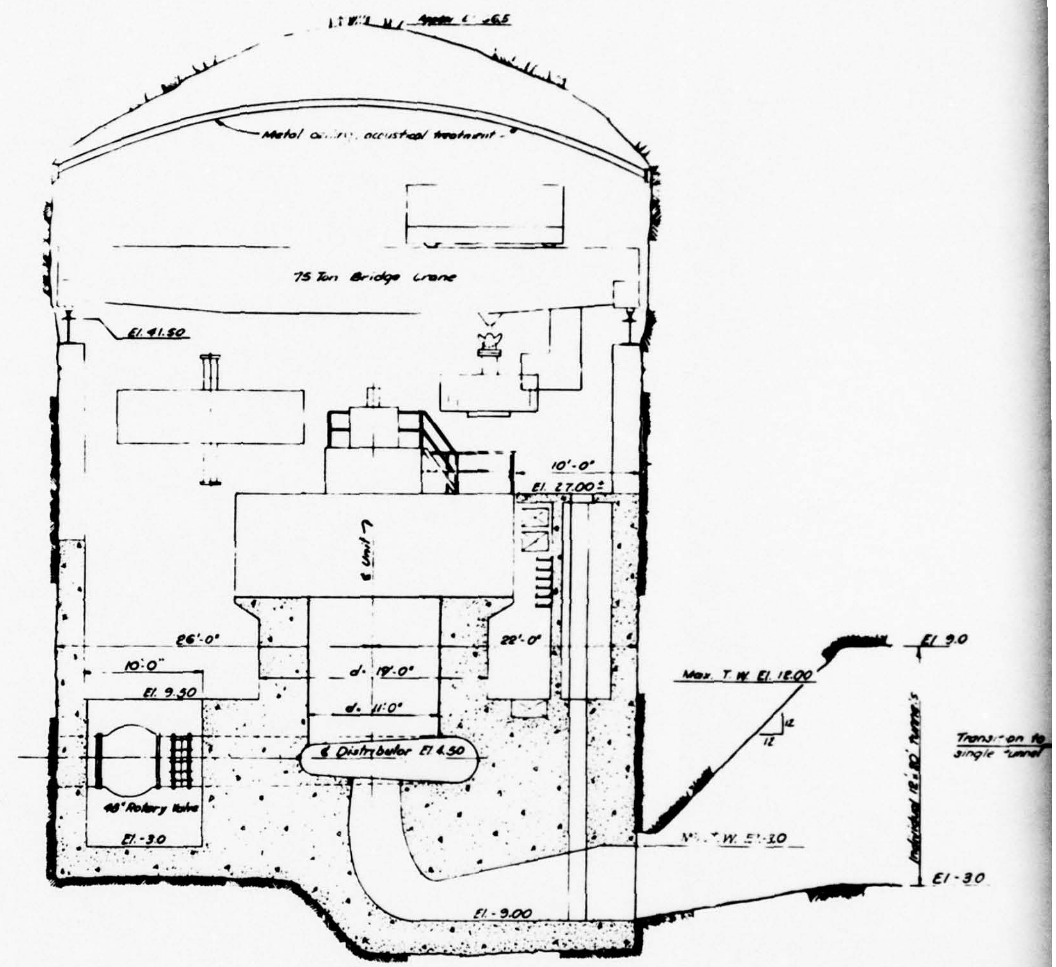
SNETTISHAM PROJECT
ALASKA
POWERHOUSE UNDERGROUND
LONGIT. SECTION THRU ℄ UNITS

Scale: 3/16" = 1'-0"

SNP 0-0-0/10

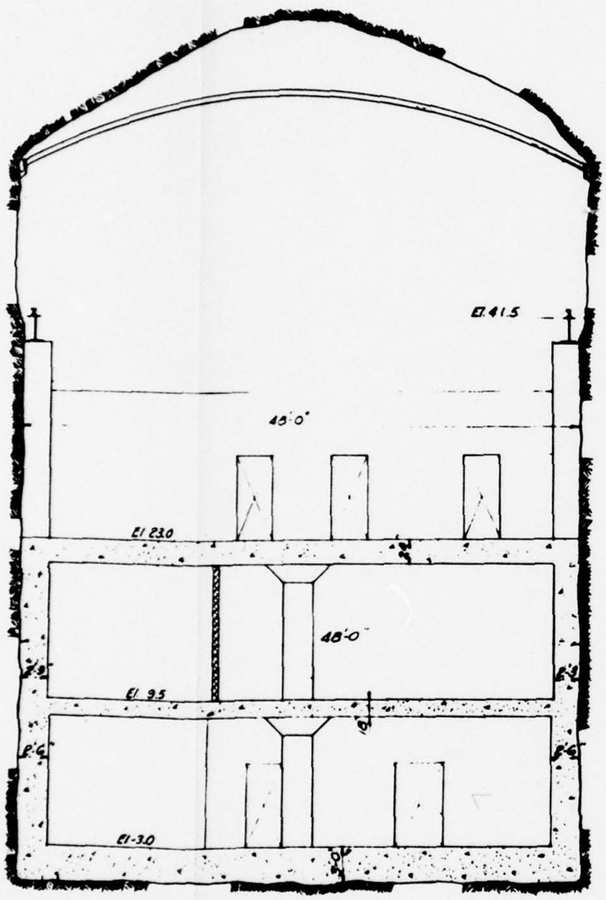
DESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 28

2


Metal ceiling, accustical treatment
75 Ton Bridge Crane
El. 41.50
10'-0"
El. 27.00±
℄ Unit 7
26'-0"
22'-0"
10'-0"
El. 9.50
d. 19'-0"
d. 11'-0"
℄ Distributor El. 4.50
48" Rotary Valve
El. -3.0
El. -9.00
El. 9.0
Max. T.W. El. 18.00
Transition to single tunnel
El. -3.0

MAIN UNIT

U. S. ARMY



ERECTION BAY

Revision	Date	Description	By
1	10 Oct 65	Added tunnel note & Section thru Erection Bay	

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

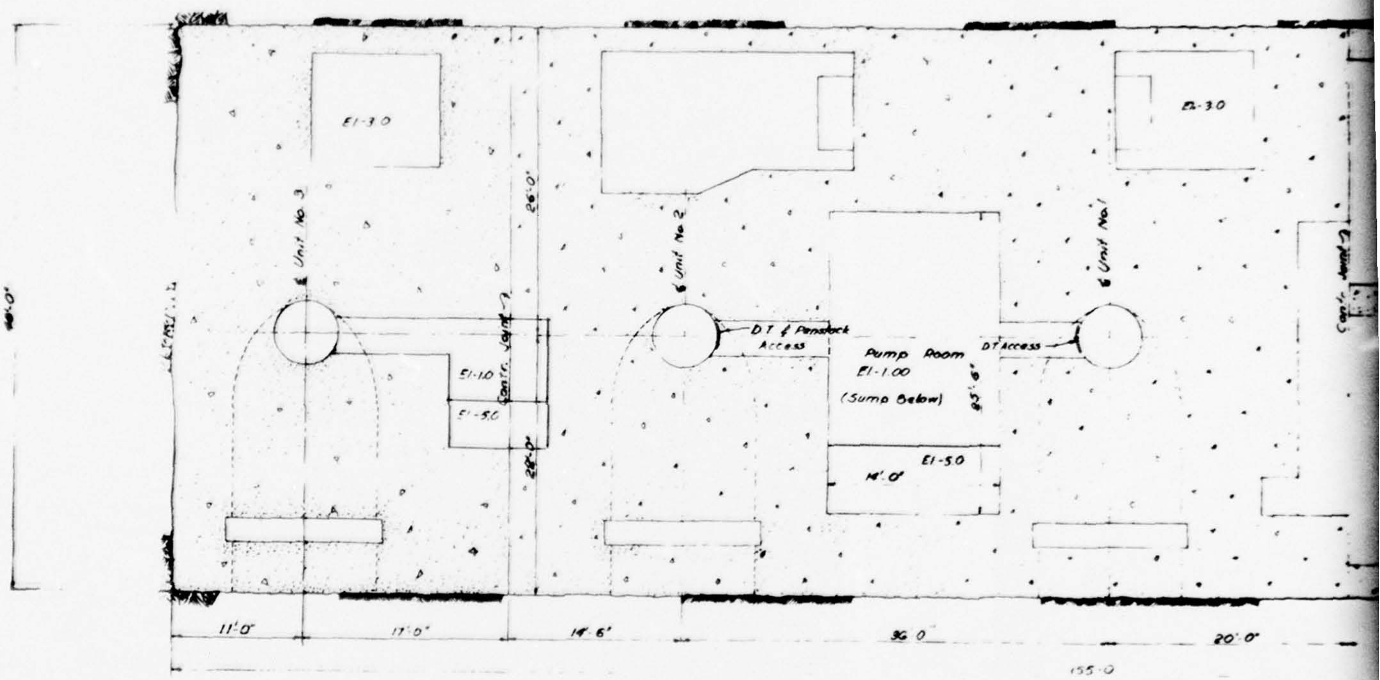
Designed by K.L.
Drawn by V.S.
Checked by

SNETTISHAM PROJECT
ALASKA
POWERHOUSE UNDERGROUND
TRANSVERSE SECTIONS

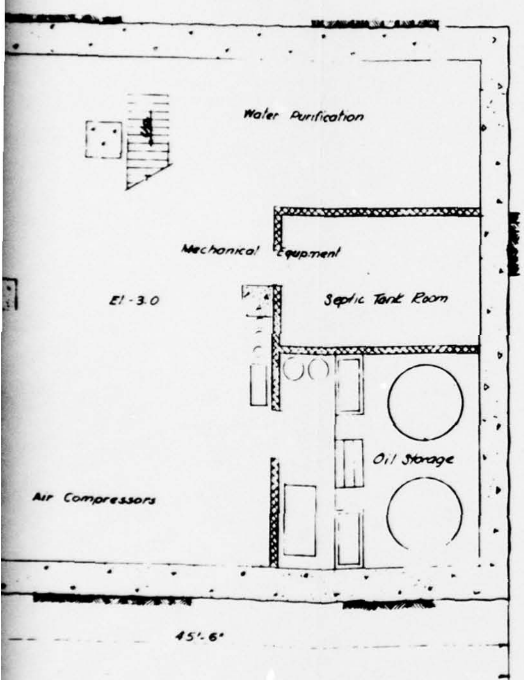
SNP 0-0-0/9

DESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 29.

CORPS OF ENGINEERS



U. S. ARMY



REVISION	DATE	DESCRIPTION	BY
1	10Oct 65	Increased Erection Bay length	[illegible]

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

SNETTISHAM PROJECT
ALASKA
POWERHOUSE UNDERGROUND
PLAN - EL.-3.0

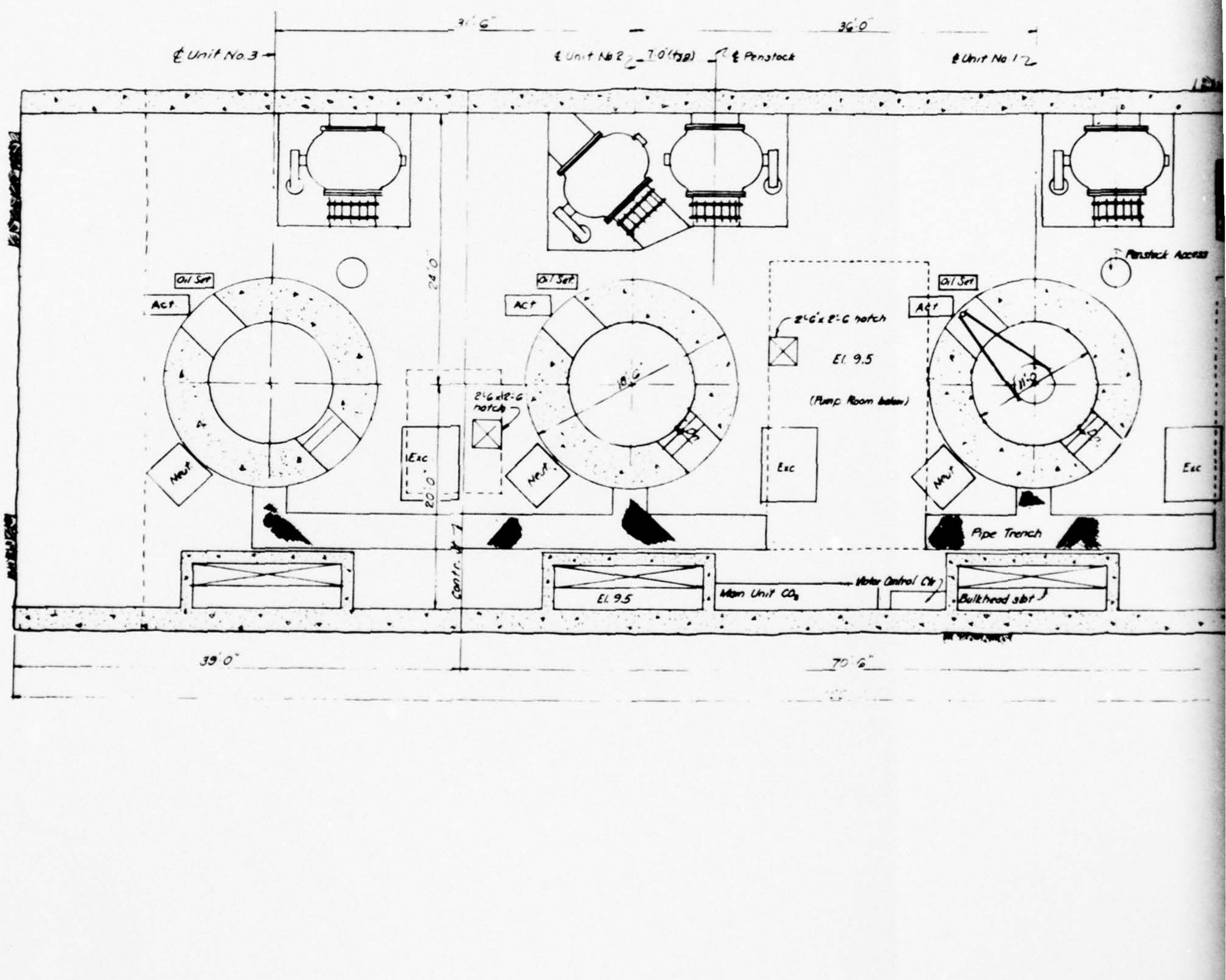
DESIGNED BY K.L.L.
DRAWN BY V.S.
CHECKED BY

SCALE: 3/16" = 1'-0"

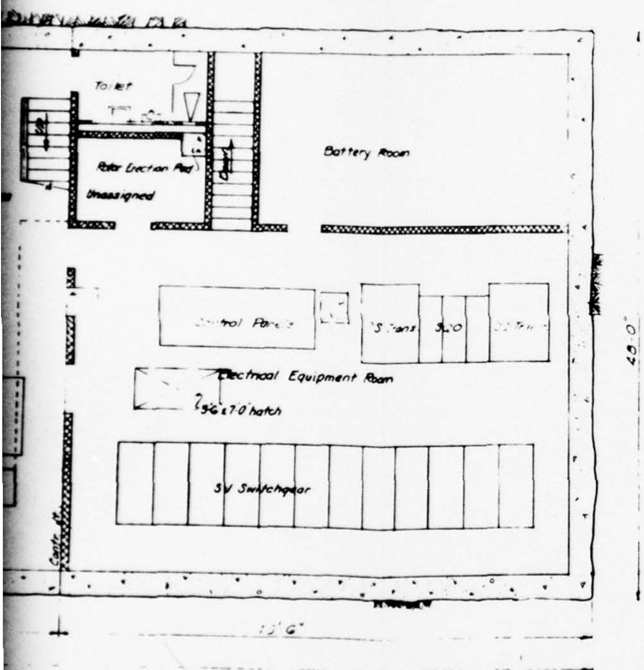
SNP 0-0-0/8

DESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 30

CORPS OF ENGINEERS



U. S. ARMY



1	Oct '65	Increased Erection Bay width	
REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

DESIGNED BY KJL
DRAWN BY KJL
CHECKED BY

SNETTISHAM PROJECT
ALASKA
POWERHOUSE UNDERGROUND
PLAN - EL. 9.5

SUBMITTED

APPROVED

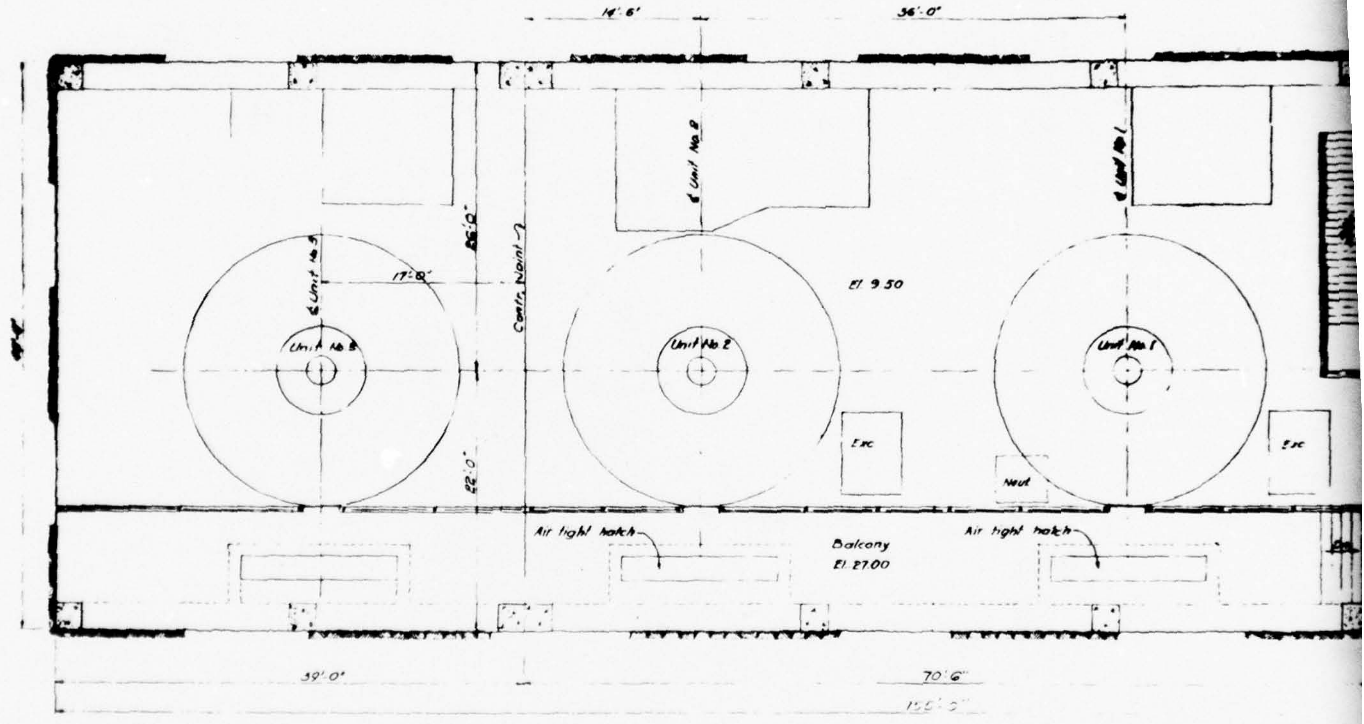
SCALE: 3/16" = 1'-0"
SPEC. NO.

SNP 0-0-0/7

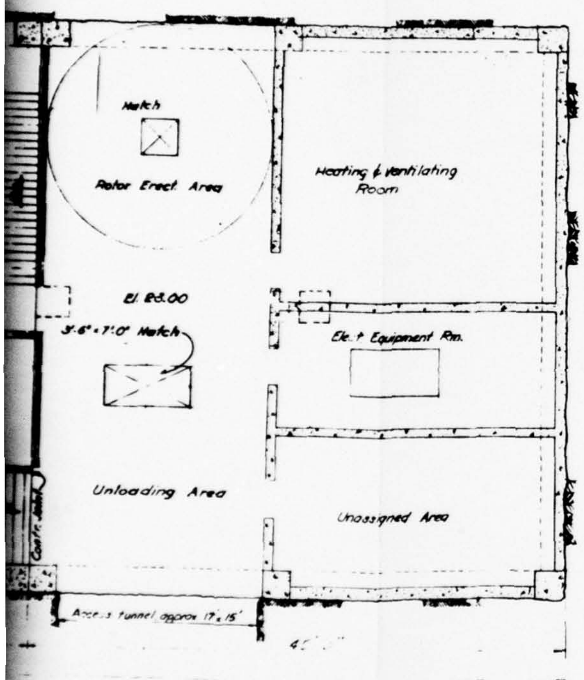
DESIGN MEMORANDUM NO.7 APPENDIX A PLATE 31

2

CORPS OF ENGINEERS



U. S. ARMY



REVISION	DATE	DESCRIPTION	BY
1	10 Oct 65	Increased Erection Bay width	

CORPS OF ENGINEERS, U. S. ARMY
NORTH PACIFIC DIVISION, PORTLAND, OREGON

DESIGNED BY K.H.
DRAWN BY V.S.
CHECKED BY

SNETTISHAM PROJECT
ALASKA
POWERHOUSE UNDERGROUND
PLAN - EL. 23.0

SCALE: 3/16" = 1'-0"

SNP 0-0-0/6

DESIGN MEMORANDUM NO. 7 APPENDIX A PLATE 32

2

APPENDIX B

AD-A067 895 CORPS OF ENGINEERS ANCHORAGE AK ALASKA DISTRICT F/G 13/2
SNETTISHAM PROJECT ALASKA. FIRST STAGE DEVELOPMENT. DESIGN MEMO--ETC(U)
OCT 65

UNCLASSIFIED NL

3 OF 6

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A067895

SNETTISHAM PROJECT, ALASKA

DESIGN MEMORANDUM NO. 7

Appendix B - Transmission

PERTINENT DATA

TRANSMISSION SYSTEM

LOCATION:

Juneau substation, 2 miles southwest of Juneau, along Gastineau Channel, across Taku Inlet, down Stephens Passage, along Speel Arm, to the Snettisham Switchyard, near the mouth of Speel River.

AUTHORIZED:

Flood Control Act 1962, providing for design and construction by the Corps of Engineers and for operation and maintenance by the Bureau of Reclamation.

PLAN:

Construct a switchyard, with transformers, at Snettisham to raise the generator voltage from 13.8kv to 138kv. Transmit a maximum of 77 MVA along 44.6 miles of overhead conductor and through 2.7 miles of submarine cable to Juneau substation. Construct Juneau substation for transforming the power to 69 and 23kv.

PROJECT FEATURES

POWER:

Voltage	138kv
Energy transmitted	331,000,000KWH/yr
Power, maximum	69MW

CAPACITY:

Juneau substation capacity	80MVA
Snettisham switchyard capacity	78MVA
Submarine cable capacity	113MVA

CONDUCTOR:

Size, conductor	795MCM ACSR
Phase spacing, wood structures	14.5 ft
Phase spacing, steel structures	22 ft
Ground clearance	Per NESC

SUBMARINE CABLE:

Size, conductor	250MCM
Insulation	Paper
Type	Oil-filled
Sheath	Lead
Armor	Steel
Length, each cable	14,250 ft
Number, cables	4

STRUCTURES:

Wood	39.3 miles
Steel	5.3 miles

SNETTISHAM DESIGN MEMORANDUM NO. 7
GENERAL DESIGN MEMORANDUM

Appendix B - Transmission

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(continued)

TABLE OF CONTENTS
(continued)

SECTION 1

GENERAL

SNETTISHAM DESIGN MEMORANDUM NO. 7
GENERAL DESIGN MEMORANDUM

APPENDIX B - TRANSMISSION

SECTION 1 - GENERAL

1-01 SCOPE:

In this appendix to Design Memorandum No. 7, major features of the transmission line and terminal facilities are determined. Design Memorandum No. 9, Transmission Facilities (Dec 66) will include line profiles, pole and tower selection and spotting, submarine cable location and terminal design. Procedures will be based upon selection of most desirable design features while clearly depicting governing parameters to facilitate free use of value engineering even into construction stage.

1-02 BASIC DATA AND CRITERIA:

a. EM 1110-2-1801, Geological Investigations

b. EM 1110-2-1002, Maps and Drawings

c. EM 1110-2-1150, Definite Project Studies

d. ER 1110-2-100, Periodic Inspection and Continuing Evaluation

e. Bonneville Power Administration Design Standards

Basic data and criteria for transmission line and substation was received from USBR. Additional data on salt water insulator contamination was obtained from BPA. Submarine cable data was obtained from Puget Sound Power and Light and BPA as well as from manufacturers.

1-03 INVESTIGATIONS:

Field investigations leading to House Document No. 40, 87th Congress, 1st Session, included preliminary surveying on transmission line route. In 1964 the area from Snettisham to Juneau was mapped utilizing high level

aerial photography for preliminary route location. In July 1965 the line route was located and marked from Snettisham to Thane. During summer of 1965 loggers cleared turn points on transmission line route from Snettisham to Taku Inlet. The balance of the clearing and a profile survey along the route will be accomplished in 1966.

1-04 LOCAL COOPERATION AND VIEWS:

The project is not dependent upon contributions by local interests; however, citizens and local groups are actively supporting accomplishment of project construction. The City of Juneau has taken steps to make available to the Government the former city garbage dump for Juneau substation.

1-05 CLIMATE:

a. General - The weather in the transmission line area is primarily influenced by maritime conditions that prevail all along southeastern Alaska. The area is in the path of storms crossing the Gulf of Alaska. The weather is varied by mountainous nature of the terrain and different conditions can exist within a few miles of each other along the transmission route.

b. Winds - Wind along the transmission line can vary considerably due to the topographic features. The maximum recorded one minute velocity from 1917 to 1959 in the Juneau area is 68 miles per hour from the north and the southeast. Local residents have reported higher velocities during Taku winds; however, the location of gaging stations is such that there has been no recording of these winds. The Taku wind is a katabatic wind which is caused by the downflow of cold, dense air off of the Juneau ice cap. This wind flows down various natural drainages such as Lynn Canal and Taku Inlet to the warmer lower pressure maritime areas. There are no

recording stations along Taku Inlet Arm or Speel Inlet. Few people have experience in Speel Arm or Taku Inlet during the winter when these winds blow. After extensive checking, the best source of reliable information appeared to be the Captains of the Alaska Marine Highway Ferries which observe regular schedules along Taku Inlet and Lynn Canal. The Captains report that when Taku winds blow, katabatic winds also blow along Lynn Canal with similar force. Therefore, it is assumed that wind velocities at Point Retreat, a lighthouse on the tip of Admiralty Island, would be representative. A fifteen-year record of the one minute winds was obtained for this location and a frequency distribution curve was plotted as shown in Figure 1. The hundred-year wind became 110 mph, the 1000 year wind became 127 mph and the 10,000-year wind became 147 mph. To check the above assumptions the Alaska District expects to install a wind recording station along Taku Inlet in the fall of 1965. It is expected that over much of the line, winds will be considerably below the maximum velocity due to increased frictional resistance of the land and surrounding trees. In certain areas funneling could occur and winds could approach the maximum velocity of 147 miles per hour. Reports have indicated that downslope winds confined in narrow gullies have toppled groups of trees in their path. This indicates the difficulty in predicting the occurrence of these winds. There is topographic evidence and a few verbal reports which lead to the assumption that these winds can be expected along Speel River and Speel Arm. However, the wind is not expected to reach velocities as high as those along Taku Arm where drainage is directly off of glacier fields.

c. Icing - Icing is not expected to be a problem along much of the line. Lines in the Juneau vicinity have had no reported failures due to

icing when they are located in the vicinity of tidewater. The Alaska-Juneau Mining Company has a line which passes over Annex Pass to their Annex Creek hydro-plant. This line reaches a maximum elevation of about 3700 feet. The A-J Company has had few icing problems below 2000 feet. Above this elevation icing has been reported up to barrel size (Photos 1-4). They have gone to a 1/2 inch steel guy wire conductor and to protect the conductor run reactive current to keep losses up. Their reported loss on this section is about 500KW of their 3500KW load. National Electrical Safety Code heavy (1/2 inch ice) loading would be sufficient from Juneau to Mallard Cove. From Mallard Cove up Speel Arm to Snettisham, the conditions and the desire for line reliability should call for an increase in loading to 1 inch of radial ice. The following reasons are given in support of this view.

(1) The line rises to a higher elevation from Bride Point for several miles in the Juneau direction.

(2) Precipitation is far heavier along Speel Arm than in the Juneau area.

(3) The prevailing winds are from the Pacific Ocean. Because of the orientation of Speel Arm and its narrowness these winds probably pass over the Arm and deposit their moisture from higher altitudes in the form of snow and therefore do not exert the warming influence that is felt in the Juneau and Taku Arm areas.

(4) Speel Arm has been reported to have frozen over to Mallard Cove in the past. Because of its shape, it probably does not receive the influx of warm water which has kept Gastineau Channel and Taku Inlet free of ice and also because cold fresh water from the Speel River can stratify in this area; therefore, the sum of these observations indicates that the

line from Mallard Cove to Snettisham may be in conditions approximating a higher altitude. That is, higher precipitation and lower temperatures and should have more allowance for ice load. It is not expected that conductor heating will have a significant effect on ice buildup and has been ignored in this design. (Reference 13)

d. Coincident Ice and Wind Loads - Coincidence of maximum ice loads and wind loads is not expected to occur. The maximum katabatic winds carry little moisture as they come from the cold glacier fields. They are warmed as they pass into the transmission area. Therefore, the NESC heavy loading of 1/2 radial ice (or 1 inch radial ice, as outlined previously) plus 4 pound wind load plus the Code constant at 0°F will be sufficient for conductor sagging.

e. Temperatures - Recorded air temperatures in the Juneau area range from a low of -21°F to a high of +89°F with an average annual temperature of 40.3°F. There are no temperature records along Speel Arm. Maximum winter temperatures will probably be lower and it is possible summer temperatures may be higher along Speel Arm because of less moderation by sea water in the vicinity.

f. Sea Temperatures - Sea water temperatures at the cable crossing were obtained from the Institute of Marine Science, Douglas Marine Station, in Juneau. Bottom temperatures are from 37.4°F to 39.2°F year around. At the surface, temperatures have been recorded from 28.4°F for a winter low to a summer high of 49.7°F. These surface temperatures were obtained with relatively few measurements.

g. Isokeraunic Level - The isokeraunic level in the Juneau area is very low, less than one occurrence per year. Thunderstorms have only been

recorded in Juneau in the months of January, June, July and September. From 1949 to 1964 there were 5 reported thunderstorms for an isokeraunic level of 0.312 per year. The transmission route is located in mountainous country through a great many tall trees. Therefore, actual lightning strokes to the line or substations will be improbable. However, to assure protection for major equipment, overhead ground wires will be extended 1/2 mile from substations and cable terminals.

1-06 GEOLOGIC CONSIDERATION:

a. Overhead Section - Inasmuch as the exact spotting of individual transmission towers has not yet been accomplished in the field, it is not possible to completely evaluate all the wood and steel tower foundations at this time. From a brief reconnaissance of both transmission line routes however, no serious problems are anticipated in securing adequate foundations for these structures. Wherever possible, all steel tower footings will be placed on hard granitic bedrock which is known to outcrop at or close to the ground surface in many areas traversed by the line. The only potentially serious consideration to be carefully noted on each bedrock tower footing will be the possibility of slab-off failures along joints or natural partings in the rock, particularly in exceptionally steep and mountainous terrain. Wherever steel tower footings are by necessity of great depths to bedrock or placed on overburden materials, spread footings will be proportioned in accordance with specific soil types encountered. No special problems are anticipated with the foundations for the wood poles which will be utilized on most of the line. Some difficulties may be encountered however, where the transmission line crosses known muskeg areas.

b. Submarine Cable Section - Special investigations have been conducted and are continuing to be made on the foundation conditions connected with the submarine transmission line crossings of Taku Inlet (see Plate 8). The U. S. Geological Survey has run fathometer surveys across Taku Inlet along the proposed cable routes (see Plate 11), and has taken shallow drive samples of bottom sediments (Exhibit 1). In addition to this work USGS is presently conducting a "sparker" traverse of these same areas in an effort to differentiate between these bottom sediments and possible bedrock outcrops. It can be particularly important to determine the areas of sharp transitions from sediment to bedrock as these zones could subject the submarine cable to more concentrated shearing forces due to differential settlements.

c. Juneau Substation - The presently proposed location for the main receiving station at the Juneau end of the transmission line is on the city dump, located on the north side of Gastineau Channel approximately 2 miles from Juneau. At this time there are some reservations about utilizing this specific area as the site for the substation. The generally unconsolidated nature of such an artificial fill which has been built out from the water's edge with a random assortment of uncompacted materials, strongly detracts from its overall in-place stability. This could be an important consideration in connection with foundation adequacy for the relatively heavy transformers and circuit breakers. It can be an even more serious problem from the standpoint of a mass slide-out type of failure during a severe earthquake occurrence. In order to investigate these important features, the Alaska District plans to dig several backhoe pits to a depth of 20 feet and drill two churn drill holes with accompanying drive samples, to a depth

of at least 100 feet. The backhoe explorations with appropriate sampling will provide required information for the design of a suitable raft type foundation pad of reinforced concrete for the heaviest electrical equipment. The deep churn drill holes with drive samples will determine the depth of the fill material and will disclose the character of underlying natural materials, both of which will help provide required shear strengths and other data for a slip circle or wedge stability analysis of the fill area. The data obtained from these explorations will also be employed to predict settlement.

d. Snow Slide Area - The city dump location is also in the immediate proximity of a major snow slide area (see Plate 10). This snow slide area which borders the city dump on the immediate north has had a history of being active and troublesome during the winter months. An investigation will, therefore, also be made as to the possible effects of this slide on the proposed nearby structures.

e. Future Treatment - In this Design Memorandum, the principal treatment of all geological features connected with the transmission line facilities has been to outline the basic problems involved. Proposed solutions to these problems in the form of definite recommendations will be forthcoming in the specific Design Memorandum for transmission facilities.

SECTION 2

RECOMMENDED PLAN

OF

DEVELOPMENT

SECTION 2 - RECOMMENDED PLAN OF DEVELOPMENT

2-01 VOLTAGE:

a. The voltage recommended for the transmission line is 138kv. An economic analysis of all pertinent factors such as first cost and losses of the submarine cable, overhead line and the cost of the substations indicates that the 138kv voltage would have a present worth value $201,000 less than the project document 115kv line and would be $237,000 less than a 161kv line. The primary reason for this change is because the value of losses has increased since the original studies in 1959 by the U. S. Bureau of Reclamation. The energy value has increased from 6.1 mills per kwh as reported in House Document No. 40, to 9 mills. The load factor has been changed from 72 percent with 48MW installed capacity, to a load factor of 55 percent with 60.9MW installed capacity. Also, with the addition of a dam and more years of inflow record, studies show that the energy output will be 331 million kilowatts per year instead of 306 million. These factors increase the annual cost of losses.

b. Plate 12 shows a series of curves which illustrate the changes in cost of the various features with voltage changes. Also plotted is a curve of three percent load growth. This indicates that if any other plants, such as Tease Lake or Speel River (72MW and 15MW) are tied to the line, 138kv will still remain the most economical voltage, although 161kv is very little more costly.

2-02 SUBMARINE CABLE:

a. The following types of cable were considered for the crossing:

(1) Solid

(2) Low pressure gas-filled

(3) Low pressure oil-filled

(4) High pressure gas-filled

The Association of Edison Illuminating Company's specifications on the first two types of cables do not extend to the necessary voltages. Although these standards do not cover submarine cable, the manufacturers will be required to follow the applicable AEIC specifications. High pressure gas-filled cable is, to our knowledge, manufactured by only one British company and therefore, was not considered further. Pipe type cables were considered and cost figures were compiled. Pipe type cable could be four single pipes and conductors or two pipes with three cables per pipe. The result of the first alternative is high losses and the second, the purchase of two extra cables and an additional pipe for reliability. For pipe type cables, ACSR would be required to achieve enough strength to pull in the conductor. Material costs for pipe and conductor alone exceeded the cost for the oil-filled cable. When labor costs of laying are also added to material costs, the price became very much higher. Therefore, pipe type cables were no longer considered.

b. Low pressure oil-filled cable has had a long record of successful submarine use and has the advantage of ease of laying and recovery, low cost and the greater number of manufacturers producing it. Problems involved in splicing, internal and external pressure differentials, and laying have all been successfully solved by other power organizations.

c. Steel and aluminum armored oil-filled cables were investigated and steel armor had the lowest overall cost when the sum of the losses and first cost were considered. The 250MCM conductor is the minimum size recommended by the AEIC at 138kv and has a capacity of 113MVA which is 36MVA above the output of Long Lake and Crater Lake combined. Thus, future additions are

possible with this cable. These could include Dorothy Lake and Tease Lake. Therefore, the recommended submarine cable is a 250MCM lead sheathed, paper-insulated, steel armored, oil-filled cable.

2-03 CONSTRUCTION:

Wood pole construction is recommended for the majority of the line. It has the advantage of low cost, ease of maintenance, construction familiarity, and is relatively unobtrusive. In the steep area near the power plant, steel towers are recommended for their adaptability to steep slopes, absence of guys and ability to be airlifted in small sections.

2-04 SUBSTATION AND SWITCHYARD:

a. A switching diagram for Juneau Substation is shown on Figure 2 and its location is shown on Plates 1 and 10 and is essentially as recommended by the Bureau of Reclamation. Triple rated autotransformers with a maximum capacity of 40 MVA are shown. This capacity for each of the two transformers closely matches the capacity of the three 26 MVA transformers at the power-plant. In order to keep costs to a minimum, the second Juneau transformer is shown paralleled with the first with only isolating disconnect switches provided to allow maintenance. This decision is based on the very low probability of transformer failure. The autotransformers supply USBR standard steel construction 69kv and 23kv bays, into which the customer's distribution lines are brought. Space will be provided within the substation fence for one large building for control room, office, warehouse and garage space. Space will also be provided for outdoor storage for such items as spare poles, crossarms, large equipment and other miscellaneous items which are compatible with outside storage.

b. The switchyard at the pwerplant will be located, as shown on Plate 31 in the main report, "Powerhouse Site Plan." Initially, the switchyard will consist of two transformer bays and one line bay. To reduce costs, only disconnect switches are shown for the transformer connections to the high voltage strain bus. The switchyard will follow USBR standard steel construction.

SECTION 3

DEPARTURES

FROM

PROJECT DOCUMENT PLAN

3-01 DEPARTURES FROM PROJECT DOCUMENT PLAN:

Certain changes from Project Document Plan, as modified by USBR reappraisal were found desirable, as follows:

a. Voltage from 115kv to 138kv to reflect increased value of energy and additional generating capability.

b. Snettisham switchyard capacity from 72 MVA to 78 MVA to match generating capability.

c. Overhead line was rerouted to avoid higher elevations (special problem areas) with mileage changes as follows:

(1) Steel towers from 10.4 to 5.3 miles.

(2) Wood H-frame from 25.6 to 39.3 miles.

d. Juneau substation from 66 MVA to 80 MVA to match generating capability.

SECTION 4

ROUTES

SECTION 4 - ROUTES

4-01 BASIC ROUTE AND ALTERNATE:

a. The transmission route, as outlined in House Document No. 40, 87th Congress, 1st Session, was generally followed with the exception of the route from Prospect Point, near Mallard Cove to Circle Point, near Slocum Inlet (Plates 3, 4, 5, 6 & 7) and Cherokee Flats, near Grindstone Creek to Thane, about 4.5 miles southeast of Juneau (Plates 8 & 9).

b. The recommended route in these areas follows the shoreline. The project document route was extensively investigated. A comparative cost analysis, Exhibit 2, Selected Computations, indicated that the sea level route from Prospect Point to Circle Point portion of the line was cheaper by $355,000 PW value than the high route even though the sea level route is 19.6 miles in length compared to 11.1 miles for the high route. This was caused by the following factors:

(1) The high line was assumed to have 5.5 miles of steel structures which were designed for heavy ice and wind loadings. This 5.5 miles was mostly that portion of the line above 2000 feet in elevation. The low line was all of the wood pole type construction.

(2) The loss of power revenues is from an estimated four outage days per year on the high line and one outage day per year on the low line (Exhibit 3) USBR letter, dated 6 Nov 64. This outage figure is most likely quite conservative. A single high line outage during the winter when adverse weather conditions occur could cause a power outage for weeks. The Alaska-Juneau Mining Company with extensive experience with a high level line has unqualifiedly recommended against a high route and has results of an engineering study which indicates that an underground cable on the high

pass of their line would pay for itself in approximately two years of operation. Photographs 1 through 4 show some of the snow conditions at Annex Pass and the type of construction which has failed to withstand the snow creep and ice loadings in this area. This type of construction in wood poles is similar to that used by ALCAN (Reference 12) with tubular aluminum structures in their Kitimat to Kemano transmission line over high passes, though it predates ALCAN's construction by many years. Aerial reconnaissance during the spring indicated that deep snow forms on the route above the two thousand foot elevation, large wind cornices have been found on the northeast sides of the ridges, indicating extensive drifting snow and winds. The overall terrain indicates strong possibility of extensive conductor icing and snow creep conditions. Maintenance in this area would be impractical during much of the winter since it could only be accomplished by helicopter. Prevailing low clouds, high winds and icing could make access impossible for weeks at a time. A-J Industries has experienced periods when it has been weeks that they could not maintain their line. The section of the high line from Cherokee Flats to Thane also has similar arguments against it. Although not as high as the route from Prospect Point to Circle Point, it still reaches an elevation of close to 1900 feet above sea level. It also would be exposed to the Taku winds from the north. The only arguments for this routing is that it is about 2200 feet shorter, requires no clearing and is invisible from Gastineau Channel steamer traffic; however, since the low line is set well back from the beach and the pole heights are generally lower than the surrounding timber, it will be quite unobtrusive. A cost comparison indicates that if there were one outage day per year additional on this section of the high line, the cost would outweigh the

low line cost. Even without the additional outage figure, the costs of the lines are very close. Therefore, from a reliability standpoint the low route is considered to be the best alternative.

4-02 SUBMARINE CABLE:

The tentative submarine cable route runs from a point seven hundred feet south of the outlet of Falls Creek on the east side of the entrance to Taku Inlet to a cove about one thousand feet north of Bishop Point on the west side of the entrance to Taku Inlet. The cable will be approximately 14,250 feet in length exclusive of the shore ends. The maximum water depth is approximately 680 feet below high water (Plate 11). The major problem in route location on the cable is to avoid areas where rocks are exposed and bridging from rock to rock could take place. Tidal currents could then cause the cable to sway, abrading the armor and the cable, resulting in a fault. Various methods of exploring the bottom of Taku Inlet to determine optimum cable routing have been considered. To avoid bridging and other deleterious conditions, television cameras, probes, divers and advanced tight beam sonar have been investigated. The depth of much of the route makes all of these methods difficult. Diving can only be used at relatively shallow depths because of impaired visibility and lack of mobility. Probing is expensive and can not delineate an overall area accurately without excessive measurements. Television also is limited by visibility problems, since there is some glacial silt in the water. Tight beam sonar appears to offer greatest promise of success. Even if other methods are employed, information obtained by sonar should be invaluable. A sweep type sonar which is capable of automatically plotting a continuous cross section has been investigated. It has a beam width of two degrees and is able to discriminate

to six inches in range. However, since it has a maximum depth capability of only 480 feet, the separate transducer unit would have to be towed astern at a suitable depth to give the coverage required. Highly reflective targets, such as air filled vessels, would be used to achieve an accurate position control. Results of presently scheduled sparker survey by USGS will probably indicate that broken or exposed rock may only be a problem on the steeper slopes near the shores which areas could lie at considerable depth. Treatment of the shore ends must protect the cable from floating ice, logs, waves, boats, and vandalism. Shore ends must also be designed for maximum heat dissipation to allow the fullest capacity of the cable to be used. The cable terminal facilities need only be situated above high water, and will be designed to reduce salt spray problems on the potheads. Oil pressurization equipment will be required on each end. The most reliable pressurization is by gravity head. Route selected will have a steep rise on the Snettisham side of Taku Inlet and allow fairly close location of the oil reservoirs. On the Juneau side the banks do not rise as steeply and the oil reservoirs must be located at a greater distance from the terminal. An overhead crossing was considered for Taku Inlet but a number of factors mitigated against it, although the 12,000-foot span length is well within technical feasibility limits. The aerial span would require about 10 miles additional transmission line as it would be located up Taku Inlet at the narrowest point. This would cost about $450,000 additional. The overhead span would be exposed to the full force of Taku winds channeled through the narrow opening and it would be a hazard to extensive light aircraft travel up and down the Inlet and they, in turn, would be a hazard to the line. Its most probable outage period would be during times of

most inclement weather and replacing it might prove infeasible for weeks. Its overall cost would be higher even though short towers would suffice because of steep bank slopes. Furthermore, the steep mountain sides leading to the terminals would expose the connecting line to slide hazards.

SECTION 5

ECONOMIC ANALYSES

SECTION 5 - ECONOMIC ANALYSES

5-01 ASSUMPTIONS:

Future Developments:

a. The load and losses on the transmission line remain constant at plant capacity of 69MW from 14th year to 50th year. This is the assumption currently favored by the U. S. Bureau of Reclamation.

b. The load grows on the transmission line at 3 percent per year from 14th to 50th year.

c. The load grows at 6 percent per year from 14th to 50th year. A second line is built in the 34th year with the Juneau load equally divided between the two lines.

d. The load grows at 6 percent per year from 14th to 50th year. A second line is built in 14th year with the Juneau load equally divided between the two lines.

e. Water will be spilled for first 13 years so losses have no value during this time.

5-02 OVERHEAD LINE SECTION:

All cost comparison studies were based upon constructing 5.3 miles of steel tower line and 39.3 miles of wood pole H-frame line. Voltages from 69kv through 230kv were studied to cover all possible feasible voltages. Costs for construction were obtained from Chugach Electric Association, Anchorage, Alaska, on their 115kv line job completed in 1962 and from the Bonneville Power Administration for steel tower lines. For purposes of estimating, a profile was made from the aerial survey contour maps, Plate 5, for ten miles of the line. Structures were then spotted and 795MCM conductor sagged in with a USBR template for standard 115kv

construction. A takeoff was made to determine the number of each size and type of structure required. These figures were then used as a basis for the entire wood pole section estimate. Fog type insulators were estimated throughout. Comparison costs are tabulated and explained in Table 1.

5-03 SUBMARINE CABLE:

a. Cable - All cost comparisons were made on copper conductor, paper-insulated, oil-filled, lead-sheathed, wire armored cable, as shown in Table 6. Prices were obtained from Phelps-Dodge Copper Products Company, Bonneville Power Administration, Puget Sound Power and Light Company and Alaska Tug and Barge Company. Prices for cables with a minimum capacity of 77 MVA were obtained, both with aluminum wire armor and steel wire armor. Since ionization in the insulation limits the minimum conductor diameter at the higher voltages, the higher voltage cables have a capacity much in excess of 77 MVA as shown in the following tabulation. The MVA capacity of the land portion of the cables as submitted by Phelps-Dodge Copper Products Corporation is as follows:

	115kv		138kv		161kv	
Conductor Size	Steel Armor	Alumin Armor	Steel Armor	Alumin Armor	Steel Armor	Alumin Armor
4/0 AWG	81	91				
250 MCM			98	115	127±	150±
350 MCM				132		
450 MCM		131				
550 MCM			128			
1000 MCM	134					

b. Terminals - Terminal equipment costs were obtained from Phelps-Dodge Copper Products Corporation. These were potheads, oil reservoirs,

valve panels and miscellaneous oil treating and installation equipment. In order to increase the shore end capacity of the cables, it is planned to operate the sheath and armor insulated from the water line to the potheads. The sheath and armor of each cable will be bonded to the other cables at the water line and the potheads insulated from ground. The length of cable from the water line to the pothead will be kept short to limit the voltage developed in the insulated section of sheath and armor. A simple shelter will be built around the potheads and takeoff structure to shelter the insulators, lightning arresters and bushings against salt spray and vandalism. The potheads would be connected to the elevated oil reservoirs by suitable piping to provide gravity pressurization of the cables.

c. Cable Laying - The cable laying cost estimates are based on utilizing one large barge, one large tug and four smaller tugs to keep very close position control. Transit men and radios would be utilized on each shore. The cables would be laid one at a time utilizing a dynamometer to keep accurate tension control, with laying speed not over 1 to 2 miles per hour. Dolphins or other suitable anchoring is contemplated to hold the barge stationary while the cable ends are taken ashore.

d. Splicing - A considerable sum was allowed in the estimate to permit splicing of cable in Seattle, probably on the barge, since the domestic manufacturers may not be able to supply the required lengths in one piece. This sum should cover the rental or fabrication of four large reels and the rereeling of the spliced cable on the drum. If the splices cannot be placed on a reel, the cable may be coiled in the barge compartments for shipment to Juneau and subsequent laying.

5-04 SUBSTATION AND SWITCHYARD:

Comparisons were made at voltages of 69 through 230kv. A one-line switching diagram for line voltages from 115 through 230kv is shown in Figure 2, except that a three-winding transformer would have to be used for 161 and 230kv. Substation costs were obtained for USBR Anchorage Substation, from estimating section of Chief Engineer's office of the Bureau in Denver and from current manufacturer's catalogs. Comparative costs are tabulated and explained in Table 2.

5-05 SUMMARY OF ANALYSES:

The cheapest overall combination of overhead line, submarine cable, Juneau Substation and Snettisham switchyard, including the future additions to the substation and switchyard for each voltage is as follows. These figures are not construction costs but include items such as losses, O & M expenses, interim replacements, etc. Line losses are based on Assumption A: (4-01)

115kv

Overhead conductor, 954 MCM --------------------	$3,585,000
Submarine cable, 4/0 AWG, steel armor ----------	1,094,000
Terminals --------------------------------------	1,315,000
TOTAL ---------------	$5,994,000
Annual Cost ---------	238,500

138kv

Overhead conductor, 795 MCM --------------------	$3,447,000
Submarine cable, 250 MCM, steel armor ----------	1,012,000
Terminals --------------------------------------	1,334,000
TOTAL ---------------	$5,793,000
Annual Cost ---------	230,500

161kv

Overhead conductor, 556.5 MCM -------------	$3,500,000
Submarine cable, 250 MCM, steel armor -----	1,050,000
Terminals ---------------------------------	1,480,000
TOTAL -----------	$6,030,000
Annual Cost -----	240,000

These figures show 138kv to be cheapest with 115kv costing $201,000 more and 161kv $237,000 more on a present worth basis. The annual costs come out $8,000 and $9,500 more per year, respectively.

SECTION 6

LINE PERFORMANCE

SECTION 6 - LINE PERFORMANCE

6-01 REGULATION:

Calculations indicate that the voltage rise from Snettisham to Juneau with one Snettisham transformer operating will be about 8 percent. This assumed 1 percent resistance and 10 percent reactance in the transformer. This is an unlikely condition and should cause no trouble if it should occur. Assuming a maximum load of 77 MVA at 0.9 PF, the voltage drop in Juneau due to transmission line regulation is approximately 6 percent. Including the three transformers at Snettisham, this total voltage drop becomes 11.6 percent. This is well within the range of transformer tap adjustments at Juneau and Snettisham and normal range of voltage adjustment on the generating units. After full load conditions are reached, normal load variations are only from half load at night to full load in the daytime. Under this condition, the voltage variation in Juneau would be about 7 to 8 percent. This variation could be handled by adjusting generator voltage on a schedule, similar to the operation at Eklutna Power Plant, near Anchorage.

6-02 STABILITY:

Stability of the system is not a factor at this time, since there are no other comparable powerplants on the system.

6-03 CORONA:

Corona loss on a 795 MCM ACSR conductor at 138kv is no problem, being under 0.1 KW per three phase mile of line.

6-04 CAPACITY:

Due to the high value of energy, the most economical conductor also has a large excess capacity. At the 113 MVA cable capacity, the transmission line losses would be 4.2 percent.

6-05 INSULATION COORDINATION:

a. The protection afforded to equipment windings by 120kv station type lightning arresters is as follows:

Maximum 60 cycle sparkover -------------- 220kv

Maximum impulse sparkover --------------- 390kv

Maximum volts with 10,000 A discharge --- 350kv

b. The 138kv windings on the transformers will be purchased with a 450kv basic insulation level (BIL) and the submarine cable BIL will be 655kv, based on an impulse strength of 1300 volts per mil for paper insulation. (Reference 3)

c. The flashover voltage levels of the line insulators, line clearances, equipment bushings, etc will be as follows: (Reference 1)

	KV		
	60-Cycle Flashover		
	Dry	Wet	Impulse
Line insulators, 6-1/2 x 10", fog type*			
Suspension string of 8	540	360	865
Tension string of 10	650	440	1070
Clearance of 42" to poles at maximum swing angle	-	-	650
Equipment bushings	-	-	650
Equipment insulators	-	-	650

* Data from Locke Insulator Company catalog

d. With an isokeraunic level of approximately 0.33 in the Juneau area, the number of lightning outages per hundred miles of line per year will be very small. The high values of 60-cycle flashover on the line insulators is considered necessary because of the salt spray contamination problem along

the coast. Additional insulators will be used where contamination is considered to be more severe. Voltage swings under fault conditions will be low with the very low resistance grounds easily obtainable at both Snettisham and Juneau because of the proximity of salt water.

e. Switching surges will be no problem until high voltage breakers are purchased for both ends on the line. Restrike free breakers should be specified at that time as recommended by the Bureau of Reclamation.

SECTION 7

OVERHEAD LINE

SECTION 7 - OVERHEAD LINE

7-01 CONDUCTOR SAG AND STRESS REQUIREMENTS:

a. Conductor sag will be based on National Electrical Safety Code Heavy Loading for the section of the line from Juneau to Mallard Cove. This will be 1/2-inch of radial ice, 4 pounds per square foot of wind and the NESC constant at 0°F. The section of line from Mallard Cove to the powerplant will be designed for 1-inch of radial ice, 4 pounds per square foot of wind and the NESC constant at 0°F. The maximum conductor temperature for sagging purposes will be the usually used 120 degrees even though the ambient temperature does not exceed 84°F since the line may at some time carry additional load. Maximum conductor temperatures were calculated with sun on the line and an emissivity of the conductor of 0.5 (Reference 6). The following results were obtained for a 26/7 795MCM conductor:

TABLE OF CONDUCTOR HEATING

Peak Load MVA	Amps	(1) Temp. Rise °F	(2) Temp. Max. °F	Sum 1&2 °F	(3) Temp. Max. Usual °F	Sum 1&3 °F
77	320	9	89	98	84	93
144	640	34	89	123	84	118

b. Wind loading on conductors and insulators was calculated by the equation $P = 0.0025V^2$, where P is pounds per square foot and V is wind velocity in miles per hour. Although a 10,000-year wind velocity of 147 miles per hour is indicated by Figure 1, "Wind Velocity Frequency," tests conducted in Europe show that the maximum wind pressure does not exceed 10 pounds per square foot on the conductor (Reference 11). Because the area is rough and covered with timber, it is expected that wind effectiveness will actually be below 10 pounds per square foot.

c. Reference 11 also states that short term gusts have no apparent effect on conductor swing angles. Reference 8 states that maximum velocities should be used for the structures as short term gusts are capable of enveloping the entire structure. Therefore, the structures will be designed for a 147 mph wind. The safety factor will be reduced because of the very low probability of this 10,000 year wind. Wood pole structure design is based on standard strengths in each class of pole. Since these are minimum pole strengths, variations in strength above this minimum result in a statistically stronger line. By selection of the larger poles for those structures which are apt to be exposed to greater stresses, the probabilities of failure are greatly reduced.

d. The maximum working tension of the conductor will be about 25 percent of ultimate or around 7,800 pounds. This allows low everyday stress and decreases the probability of failure due to aeolian vibration. Generally, vibration is not expected to be a hazard along the line because the topographic conditions required for a steady wind are not available. However, because of the low cost of damping devices, they will be used on the line. Long spans such as those near Snettisham, Mallard Cove and Limestone Inlet will receive special attention in this respect. An added advantage of lower conductor tensions is that the conductor sag will more generally conform to the steep slopes, reducing the requirements for hold-down weights and tension structures. Longer spans, such as Limestone Inlet, (1,800' approximately) may be strung at higher maximum working tensions, if required. However, the slopes are generally steep enough at the crossings to allow stringing with standard tension.

7-02 CONDUCTOR CONSTRUCTION:

The conductor will be 795 MCM, comprised of 26 strands of aluminum

SECTION 7 - OVERHEAD LINE

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TABLE OF CONDUCTOR HEATING

		(1)	(2)		(3)	
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144	640	34	89	123	84	118

b. Wind loading on conductors and insulators was calculated by the equation $P = 0.0025V^2$, where P is pounds per square foot and V is wind velocity in miles per hour. Although a 10,000-year wind velocity of 147 miles per hour is indicated by Figure 1, "Wind Velocity Frequency," tests conducted in Europe show that the maximum wind pressure does not exceed 10 pounds per square foot on the conductor (Reference 11). Because the area is rough and covered with timber, it is expected that wind effectiveness will actually be below 10 pounds per square foot.

c. Reference 11 also states that short term gusts have no apparent effect on conductor swing angles. Reference 8 states that maximum velocities should be used for the structures as short term gusts are capable of enveloping the entire structure. Therefore, the structures will be designed for a 147 mph wind. The safety factor will be reduced because of the very low probability of this 10,000 year wind. Wood pole structure design is based on standard strengths in each class of pole. Since these are minimum pole strengths, variations in strength above this minimum result in a statistically stronger line. By selection of the larger poles for those structures which are apt to be exposed to greater stresses, the probabilities of failure are greatly reduced.

d. The maximum working tension of the conductor will be about 25 percent of ultimate or around 7,800 pounds. This allows low everyday stress and decreases the probability of failure due to aeolian vibration. Generally, vibration is not expected to be a hazard along the line because the topographic conditions required for a steady wind are not available. However, because of the low cost of damping devices, they will be used on the line. Long spans such as those near Snettisham, Mallard Cove and Limestone Inlet will receive special attention in this respect. An added advantage of lower conductor tensions is that the conductor sag will more generally conform to the steep slopes, reducing the requirements for hold-down weights and tension structures. Longer spans, such as Limestone Inlet, (1,800' approximately) may be strung at higher maximum working tensions, if required. However, the slopes are generally steep enough at the crossings to allow stringing with standard tension.

7-02 CONDUCTOR CONSTRUCTION:

The conductor will be 795 MCM, comprised of 26 strands of aluminum

and 7 strands of steel. It will be 1.108 inches in diameter and have an ultimate strength of 31,200 pounds. The resistivity at 60 cycles will be approximately 0.117 ohms per mile. All of the transmission line can be considered within the area where salt spray in some quantity is possible. For this reason the steel core strands will be aluminum clad to reduce corrosion.

7-03 CONDUCTOR SPACING:

Conductor spacing will be a basic 14.5 feet for the wood pole and approximately 22 feet in the steel section of the line except for long spans. At these points additional separation to allow for one or two node conductor galloping will be used (Reference 14).

7-04 INSULATORS:

The line is all within the area where some salt spray contamination is possible. Bonneville Power Administration states that their lines along the Oregon-Washington coast have become contaminated up to five miles inland. BPA lines are subjected to worse conditions than the Snettisham line in that the beaches are exposed to higher salinity open ocean spray and the Oregon-Washington region has longer periods of dry weather where rainfall does not wash the accumulated salt off the insulators. BPA has found that 6 fog type insulators give good protection to their 115kv lines where they have had flashovers with as many as seven standard insulators. The Alaska District discussed with BPA the feasibility of putting in test insulator strings to get data on contamination (BPA has insulation test installations on the Oregon-Washington coast). It was pointed out that the period of record would not be sufficient and that conditions were probably too variable to permit any significant results. Fog type insulators as listed below will be used on the line.

TABLE INSULATOR REQUIREMENTS

Structure Types (Reference 9)	No. Suspension Insulator/Phase	No. Tension or Angle Insulators/Phase
HS, HSB	8	
3A, 3AB, 3AT, 3AC		10
3T, 3TX	8	10
Steel	10	11

Where strings are inclined from the horizontal, the insulators will be placed so the bowls are facing downward. The insulators will be 10-1/2 by 6-1/2 inch with ball and socket fittings. Insulators with 5-3/4 inch spacing were considered but other agencies' experience has shown that hot line work is difficult with the closer spacings. The insulators will be of the 25,000 pound M&E type. Where additional strength on dead ends or angle structures is required, yokes and double strings will be used.

7-05 HARDWARE:

Wood pole hardware will conform to the general types outlined in the USBR's "Standard Specifications and Drawings for Construction" of 138kv and 161kv wood-pole, H-frame Transmission Lines, October 1960 (Reference 9). Crossarm hardware will be grounded by copper wire which will run down one pole and be wrapped around the butt of the pole as shown on Drawing 40-D-4978 in Reference 9. The hardware grounding is to prevent leakage currents from causing crossarm and pole burning under contaminated insulator conditions.

7-06 STRUCTURES:

a. Suitability to Sites - Wood pole structures will be used throughout the line except in the area from Snettisham 5.3 miles toward Juneau, where steel towers will be used (Plates 2 & 3). The selection of the individual structures will depend on conductor tension, span lengths, wind and ice

loadings, clearances, topography, reliability desired and geologic conditions. In general, structures will be located on high points where feasible. When possible, they will also avoid swamps, lakes, bays and slide areas. The line was located so as to be as accessible as possible, achieve minimum length and cost and be far enough from the salt water shoreline to minimize salt contamination. The section from the plant to mile 5.3 had no easy solution because of the steepness of the terrain and the scarcity of suitable sites to place the structures. Steel towers were selected for this portion of the line for the following reasons:

(1) Guying problems are avoided.

(2) Installation is easier. The steel towers can utilize a grouted steel bar for each leg. The bar hole may be either 3-1/2 or 4-inch and may be drilled with normal equipment without blasting which might disturb the surrounding rock. Steel towers also have greater adaptability to very steep slopes. The steel tower may have a 5-foot uphill leg and a 35-foot downhill leg with a 65-foot tower body; this would require a 70-foot uphill pole and a 95-foot downhill pole to achieve the same maximum 60° slope with 12-foot pole spacing. To blast a pole hole in rock, however, would require benching into the hillside to prevent breakout of the hole which would result in additional length added to the poles.

(3) Steel towers, if damaged, can be replaced in segments which lie within the lifting capability of small helicopters. Further, if the steel tower is damaged new legs can be welded to the reinforcing bar type footing using light portable welders. In the case of wood poles the stub would have to be removed and a new pole placed. This would require time-consuming digging in frozen earth or rock if the pole were broken in the winter or

spring period when a slide is most probable. If powder were used to remove the pole, replacing the pole would require aerial transport of backfill.

b. Ease of Erection - All structures will be designed for ease of erection. Where feasible, structures have been kept off steep hillsides. Wherever possible, similar materials will be used throughout so as to reduce to a minimum the stocking of material and requirements for transporting different types of materials during outages. Crossarms will all be of the sawn type. Consideration was given to spar types for simplicity of helicopter erection; however, linemen have difficulty standing on spars, hardware problems, reduced strengths, eccentric loading and checking causing rotting were factors which weighed against their use. Wood pole structures will be designed wherever possible, to be within the lifting capability of a 4,000 pound lift helicopter. Much of the line will most likely be constructed by helicopter since a good portion of terrain is too rocky, steep and timber covered to allow economic construction of roads and cat trails. If helicopters will be required on a major portion of the line, the contractor will undoubtedly utilize the machines throughout so as to reduce equipment and scheduling operations to a minimum. Further, with advent of heavy use of helicopters for military operations, greater volume production of the larger machines will reduce their costs and increase their availability. Helicopters have proven economical for line construction in many areas less rugged than the Juneau area. Some information on helicopters in construction is contained in References 15 to 34 and Section 9 following.

c. Availability of Materials - The materials for the transmission line wood structures are readily obtainable in the Pacific Northwest. The hardware will be standard type obtainable from a number of manufacturers

in the United States. Wherever possible hardware types will conform to those utilized by the Bureau of Reclamation to reduce maintenance supply problems. Steel towers are available from manufacturers in the United States; however, other government agencies are able to obtain very low prices from European companies. Towers will be standard with types used by large transmission line builders wherever possible to take advantage of reduced manufacturer set up costs, availability of replacement material and testing and design experience of other agencies. Suitable fog type insulators can be obtained in the United States from a number of manufacturers. Again, foreign manufacturers have supplied insulators at very low cost to other agencies. Generally foreign manufacturers will probably not bid on Snettisham equipment unless the balance of payments becomes favorable for the United States. The Corps of Engineers' policy, as outlined in ASPR 6-104.4(b) adds 50 percent to their bid prices for bid evaluation. Since United States manufacturers are aware of this, it is most probable that the Corps of Engineers will not be able to achieve the same costs on supplied equipment as are possible by other agencies. Ready mix concrete will be available in the Juneau area for the Juneau substation. The Taku Arm cable terminals will require the shipment of prescreened and washed gravel for the construction of the concrete portion of these facilities. Cable ducts and cable covers could be precast and shipped by barge to the terminals to reduce the volume of concrete to be mixed at these locations. Along the line, concrete requirements will be a minimum, generally limited to grouting at various tower footings. This requirement will be minimal for drilled hole type footings. For concrete pad type footings, of which there may be only a few, requirements for concrete will have to be met by helicopter supply. Probably mixing on a barge

and lifting concrete directly to the tower footings by helicopter will be the most economical. Near Snettisham, concrete and aggregate will be available from the contractor building the dam, powerplant and other works. Gravel in quantity is in short supply along the transmission route. The only sources are the outfalls of the creeks and a small amount along the beaches. A good supply of gravel can be found at Falls Creek, Taku Harbor, Limestone Inlet, Slocum Inlet and Crater Cove near the powerplant. Any large requirement for gravel or rock for the construction of roads may have to be met by crushing and/or blasting of rock. In certain areas, pole holes in rock, which will be excavated by blasting, may be deficient in rock backfill. In these cases backfill may have to be supplied from other sources. Rock is a desirable material for backfill where x-braced poles are expected to develop uplift forces.

7-07 SAFETY FACTORS:

The safety factors, as outlined by Reference 4, are as follows:

	@ full load	@ 60°F, no wind
Poles	2.0	5.5
Crossarms	4.0	5.5
Guys (angle)	2.0	-
Guys (line)	1.5	-
Insulator Strings	2.5	-
Conductor	2.0	4.0

Above safety factors will be checked against an ultimate load to achieve a balanced overall design (Reference 8). This will reduce the possibility that one portion of the transmission system will be much weaker. It will also allow reducing the cost on those items that are considerably stronger

than necessary. The values calculated for ultimate loads to failure may also be useful during operation of the system. If operations personnel are aware that conditions along the line are approaching ultimate loads they may be in a position to take remedial measures. The structures and line clearances will conform to the condition outlined in Reference 10, except where analysis shows other values to be more applicable. The overwater crossings, such as Limestone Inlet, must have sufficient clearance over high water to allow small craft to operate in safety. These crossings will be checked with Federal Aviation Agency for aircraft interference and marking and will also require navigation permits from the U. S. Department of the Army Permit Section.

SECTION 8

SUBMARINE CABLE

SECTION 8 - SUBMARINE CABLE

8-01 SUBMARINE CABLE:

a. The submarine cable must be designed for a number of stresses. These include laying stresses, repair stresses, oil pressurization stresses and stress generated due to temperature changes.

b. Cable laying stresses of necessity must be quite high since the cable weighs about 11.9 pounds per foot in air and about 8.9 pounds per foot in salt water and in the deeper section will be 680 feet below the laying barge. Therefore, the minimum possible tension for laying must be greater than 6000 pounds. Puget Sound Power and Light Company laid a similar cable at comparable depths with 10,000 pounds tension. The stresses in picking up the cable may be higher than those in laying.

c. The armor must be designed to protect the cable from abrasion and supply sufficient strength for laying and recovery. Galvanized steel armor has been widely used in this country for this purpose and has a record of good performance as far as strength and corrosion resistance are concerned. Aluminum armor was used on the Puget Sound Power and Light cable and has to date proved satisfactory.

d. The cable must also withstand oil pressures. It is desirable to keep a positive pressure at all times on the cable. Under load changes there is a change in oil temperature causing oil flow either from or to the reservoirs on either end. Under conditions of decreasing load after the cable has been carrying high current the oil flows toward the center of the cable. Positive oil pressure will be required to overcome the frictional resistance of the oil flow. Since the oil is about 0.9 the specific gravity of sea water, the land end of the cable will be subjected to

about 30 pounds per square inch static pressure at all times in order to maintain positive oil pressure at the 600-foot depth. Depending on the temperature changes and cable core design, the pressure required for overcoming frictional resistance will be around 20 pounds per square inch. This gives a total pressure of 50 pounds per square inch at the shore ends of the cable. This pressure, if contained by the lead sheath alone, would cause about 370 pounds per square inch stress in the lead. To reduce stresses and creep in the lead, some of the stress will have to be carried by materials outside of the lead. Certain manufacturers of cable have prestressed the lead sheath with glass fibers bedded in PVC to overcome the lead creep which occurs at 150 to 200 pounds per square inch. Also, metallic tapes have been used.

SECTION 9

COMMUNICATIONS

SECTION 9 - COMMUNICATIONS

9-01 COMMUNICATIONS:

a. It is contemplated that the communications to be installed for the construction period will consist of four voice channels and one teletype channel on a VHF, UHF or microwave radio link. This system may be adequate for operations of the plant until it is placed under supervisory control from Juneau. At that time, additional channels can be added, up to a maximum of 96 under one scheme now being investigated.

b. There is no carrier contemplated for relaying initially so there will be no carrier communication at this time.

c. The existing low frequency radio system can be retained as backup after construction is completed.

d. The communications are covered in greater detail in a "Communication" supplement to Design Memorandum No. 5, "Access and Construction Facilities."

SECTION 10

OPERATION

AND

MAINTENANCE

SECTION 10 - OPERATION AND MAINTENANCE

10-01 TRANSMISSION LINE:

a. Inaccessibility of a large portion of the line and ruggedness of terrain will cause operation and maintenance expenses to be much higher than costs for similar voltage lines in the contiguous states. Much of the equipment required is for emergency repairs and will be used very rarely in normal operation. The line can be patrolled most economically by helicopter, and on approximately 20 miles of line, would be the only practical way. If helicopters or airplanes are used for routine transportation of operators and maintenance personnel, the route of the flights could be along the right-of-way so that relatively frequent observations would be accomplished. Helicopter landing pads will be provided at or relatively near each structure, as required, to facilitate inspection and repair. It is also possible to construct roughly 26 miles of access road along or near the line but this would still leave the above 20 miles to be done by helicopter. The design of the structures will be such that they can be constructed by a 4,000 pound capacity helicopter and would, of course, be repairable by the same means. The helicopter would also be used for the yearly brush spraying program. Danger trees and evergreens growing in the right-of-way would be cut down by the linemen on their routine line patrols.

b. Operation and maintenance costs and assumptions are discussed further in Exhibit 2 and Table 1.

c. Space is available at Snettisham and Juneau for the storage of spare poles, crossarms, hardware, insulators, conductor, guy wire and spare steel tower sections for routine and emergency repairs.

10-02 JUNEAU SUBSTATION:

Maintenance and operation should follow routine USBR standard practices with the exception that it may be necessary to wash down insulator strings and bushings on a routine basis. All washdowns in the substation can be done with the equipment de-energized and without service interruption except for transformer bushings. Fog type nozzles should allow cleaning of energized transformer bushings in safety. Of course, insulator washdown will have to be conducted when the temperatures are above freezing. Some steel structure base lifting and regrouting may be necessary due to differential settlement of the fill material.

10-03 SNETTISHAM SWITCHYARD:

Operation and maintenance should follow routine USBR practices. There is no provision for taking the transformers into the powerhouse for repair. If major work is required, a temporary shelter will have to be built over the transformer and mobile cranes brought in from Juneau, if required. This decision is based upon the very low probability of transformer trouble during the 50-year life of the project. Insulator and bushing cleaning should not be necessary because of the very low salinity of the water and the very high rainfall level in the area.

10-04 SPARES:

It is anticipated that reasonable quantities of spare items will be included in construction procurement to permit initiation of operation with a normal stock of spare parts.

SECTION 11

REAL ESTATE REQUIREMENTS

SECTION 11 - REAL ESTATE REQUIREMENTS

11-01 DESCRIPTION:

The transmission line right-of-way will be approximately 44.6 miles long and 200 feet wide containing some 1,087 acres. From its point of origin at the project site to Bishop Point, the right-of-way is located entirely upon Government-owned land with a possible exception at Taku Harbor where it may cross a small portion of private land. From Bishop Point to the Juneau townsite boundary, a distance of approximately 4-1/2 miles, the right-of-way is located sufficiently inland to avoid all but some 180 feet of private land. The distance from the townsite boundary to the termination of the transmission line near Juneau is approximately 5 miles, the ownership of which is held by private interests and the State of Alaska. The right-of-way extends approximately 900 feet across several privately owned small tracts, 18,600 feet across numerous mineral surveys and mining claims, most of which are patented and all owned by Alaska-Juneau Industries, Inc., and 14,900 feet across State land. This State land has been selected and granted tentative approval which is tantamount to ownership. The mineral surveys and claims are lying idle and have not been in production for several years. As near as can be determined there are no other such interests in either the main project area or the remainder of the transmission line right-of-way. The Juneau substation will be situated on a 400' x 400' site approximately two miles southeast of the city center. Two tentative locations are under study; however, one of them, the A-J Industries' rock dump, will not be considered further due to the high cost of acquisition. The other location is the abandoned city garbage dump which the city has indicated it would consider making available for use as a substation site.

11-02 TYPE OF ACQUISITION:

The Corps of Engineers is to acquire all the land and rights necessary for the Snettisham project and is to construct said project after which it will be turned over to the Department of Interior, Bureau of Reclamation, for operation and maintenance. The transmission line right-of-way on Federal land will be acquired by use of Forest Service Construction and Use Permits, once the location of the line is finalized. Acquisition of the transmission line right-of-way across State and private lands will be accomplished by acquiring permanent easements. Since structures of a permanent nature are to be constructed on the substation site, this land will be acquired in fee.

11-03 RELOCATIONS:

There will be no relocations of roads, railroads, pipelines, utilities or cemeteries, etc. There will be some access roads to the transmission line.

11-04 REAL ESTATE COSTS:

a. Fee - No land is to be acquired in fee other than the Juneau substation site. Present consideration is being given the abandoned city garbage dump, an area of around 7 acres located approximately 3,000 feet southeast of the A-J Industries' rock dump. The suitability of this site will depend on foundation characteristics which are unknown at this time. The city has tentatively indicated it would make the land available at no cost; however, this has not been formalized. Its value is estimated at around $25,000.

b. Easement - Of the total 1,087 acres in the transmission line right-of-way it will be necessary to acquire permanent easements covering

approximately 160 acres. This includes 69 acres of State land and 91 acres of private land. All but 5 acres of the private land consists of mineral surveys and claims owned by A-J Industries, Inc. The 5 acres involves the crossing of around four small tract ownerships of 4 to 5 acres each and a privately owned U. S. Survey tract. The actual right-of-way location has not been finalized and is subject to change at a later date. It is the policy of local power companies in both Anchorage and Juneau to acquire this type of easement for no consideration unless damages are incurred by the property owner. Even though the transmission line should be sufficiently above the road to be out of sight, its presence and the clearing of timber may still result in a loss of value to the private land amounting to as much as full value for the land involved. No sales of this land were found, however, they are valued at around $500 per acre by the Borough Assessor which appears reasonable. The mining claims have been the property of A-J Industries for many years and have not been offered for sale even though they are not being operated. The Assessor values them at $400 for a standard claim of around 20 acres or $20 per acre. The State land has not been valued by the Assessor and in all probability easements can be acquired across it for little or no consideration. For purposes of this report, however, it will be valued at $25 per acre taking into account the small amount of merchantable timber involved.

c. Administrative Costs - These costs are based upon an estimate of the actual work to be performed in acquiring the necessary real estate rights. Included are mapping and surveying, appraising, title evidence, negotiating and closing. They are listed as follows:

Mapping and Surveying	$4,000
Appraising	500
Title Evidence	350
Negotiating and Closing	650
TOTAL	$5,500

d. Summary - The following is a summary of the estimated real estate costs as of this time. Since the availability of the substation site at no cost to the Government is not presently known, its value will be included. A contingency factor of 25% is also included to cover the possibility of having to acquire easement rights over additional private land and to consider a possible increase in value from the date of this report to final project acquisition.

LAND RIGHTS

Government owned land - 923 acres	NO COST
State Land - Easement rights only	
69 acres @ $25/acre	$1,725.00
Private Land - Easement rights only	
86 acres mineral surveys @ $20/acre	$1,720.00
5 acres Small Tract Ownerships @ $500/acre	$2,500.00
Juneau Substation Site - Fee acquisition	$25,000.00
Total Cost of Land Rights	$30,945.00
Contingencies - (25% of $30,945)	$7,736.00
Administrative Costs -	5,500.00
Estimated Total of Real Estate Costs	$44,181.00
Called	$44,200.00

11-05 ACQUISITION SCHEDULE:

Application has been made for the withdrawal of Federal land in the main project area and approval is now pending. A Memorandum of Understanding between the Alaska District Engineer and the Regional Forester involving all the Federal land needed for planning and construction of the project is currently under study. It is presently the plan to have the transmission line right-of-way and substation site acquired by June 1967.

11-06 FUTURE CONSIDERATIONS:

Consideration should be given to acquiring right-of-way for a future additional line. It is anticipated that there will be little problem on the east side of Taku Inlet. On the Juneau side, the city will probably expand. Where possible, if there is no additional cost, an increased right-of-way width to 300 feet should be used. The additional width of 100 feet could be taken on the uphill side of the present projected 200-foot right-of-way. The additional width will probably fall outside of private land but will call for the additional acquisition of State of Alaska lands and mining claim lands owned by Alaska-Juneau Industries, Inc. The addition of a pulp mill could so radically alter power requirements in the Juneau area that second line planning may have to be instituted shortly after completion of the Crater-Long Lakes Project.

SECTION 12

COST ESTIMATES

SECTION 12 - COST ESTIMATES

12-01 GENERAL

a. <u>Cost Estimates</u> - The cost estimates for Appendix B were computed from data from numerous sources. These included manufacturers' quotations and catalogs, data from Bureau of Reclamation, Bonneville Power Administration, U. S. Forest Service, contractors and various bid abstracts. Material costs were escalated to present values, as necessary, with appropriate allowances for freight. Labor costs were largely based upon the following:

(1) Chugach Electric Association 90-mile, 115kv line built in 1962 from Cooper Lake to Anchorage.

(2) U. S. Bureau of Reclamation Anchorage substation 1953 bids.

(3) Puget Sound Power and Light Company experience.

(4) U. S. Forest Service experience.

(5) Bonneville Power Administration experience.

(6) Contractors and abstracts of other bids.

Labor costs were then adjusted for time, roughness of terrain, weather conditions and increased transportation difficulties.

b. <u>Contingencies</u> - Contingencies used are 25 percent. More accurate estimates will be made upon completion of field work now scheduled for the summer of 1966. At that time the specific number of structures, their heights, accurate line and cable lengths, substation foundation conditions, tower weights and substation steel will be determined.

c. <u>Summary</u> - Summary by item and feature is included in this section. Also included are more detailed breakdowns of items used in the cost estimate. These estimates do not include contractor's profit and overhead which are included in the aforementioned summary.

The detailed estimate on "Land Rights and Rights-of-Way" can be found in Section 11 of this Appendix, titled "Real Estate Requirements." The detailed estimate for "Structures and Imprvements" is shown under the breakdown for "Station Equipment" and consists of a $68,000 building for Juneau substation. The detailed estimates for "Poles and Fixtures," as well as a portion of "Overhead Conductors and Devices', are tabulated in Tables 3, 4 and 5.

SECTION 12 - TRANSMISSION PLANT
COST ESTIMATE SUMMARY

Acc't No.	Account Description	Cost ($1,000) Juneau Substation	Snettisham Switchyard	Overhead Line	Submarine Cable	Government Cost 25%	Totals by Accounts
07.80	Land and Land Rights	$ 25.0	$ 0	$ 8.6	$ 0	$ 8.4	$ 42.0
07.81	Clearing and Rights of Way	0	0	353.1	0	87.9	441.0
07.82	Structures and Improvements	74.8	55.0	0	0	32.2	162.0
07.83	Station Equipment	670.6	248.2	0	0	230.2	1,149.0
07.84	Towers and Fixtures	0	0	293.2	0	73.8	367.0
07.85	Poles and Fixtures	0	0	823.5	0	205.5	1,029.0
07.86	Overhead Conductors and Devices	0	0	972.6	0	243.4	1,216.0
07.88	Underground Conductors and Devices	0	0	0	710.6	177.4	888.0
07.89	Addtnl Cost f/all weather roads	0	0	1,430.0	0	358.0	1,788.0
		$ 770.4	$ 303.2	$3,881.0	$ 710.6	$1,416.8	$7,082.0

* Based on constructing 26 miles in the areas considered feasible at $53,100 per mile plus 25% contingencies.

This figure per mile is from the Forest Service and from an Anchorage contracting firm.

Above costs include contractor's profit and overhead.

12-02 DETAILED ESTIMATE:

a. Clearing Lands & Rights-of-Way - Complete Disposal

Substation to Bishop Point

15.4 miles x 100' width

12.1 acres x 15.4 x $850/acre *	=	$158,500
North of Taku Harbor		
12.1 acres x 0.25 x $850/acre *	=	2,500
Taku Harbor		
12.1 acres x 1.25 x $850/acre *	=	12,800
Limestone Inlet		
12.1 acres x 0.9 x $850/acre *	=	9,200
	Subtotal	$183,000

b. Merchantable Timber to be Removed -

12.1 acres x 8.3 x $600/acre **	=	$ 60,000

c. Timber to fell and lop -

12.1 acres x 16 x $400/acre	=	$ 78,000
	TOTAL	$321,000

NOTE: Chugach Electric Association 1962 cost for clear, cut, grub and disposal in Chugach National Forest was $425 per acre.

* Increased cost over CEA because of bigger timber and more difficult burning conditions.

** Increased cost because timber will be lower in value than costs to remove it.

12-03 DETAILED ESTIMATE:

a. Snettisham Switchyard -		Mat'l & Frt	Labor
Land and Land Rights		0	0
Structures and Improvements			
Rockfill, 20,666 yds x $2.25			46,500
Gravel Surfacing 1,147 yds x $3.00			3,440
Subtotal			$49,940
Station Equipment:			
Bus Compartments (none)			
Conduit, buried			
for transformers - 400' of 1' = 400'			
switchyard lights- 400' of 1' = 400'			
miscellaneous - 500' of 1' = 500'			
Total footage	1,300'	600	1,200
cable trench, concrete 48" x 48" x 4"			
walls, 250' 40 cu yds		1,600	4,000
reinforcing steel @ 100 lbs/cu yd			
= 4,000 lbs		600	400
steel plate trench cover,			
1/4" x 5' x 250' = 12,500 lbs		3,000	500
Subtotal		$5,800	$6,100
Control Equipment (none)			
Conversion Equipment			
two transformers, 26MVA, 13.8-138kv		106,000	18,000
Fence, 510', 7' high, 3-strand barb			
wire top		2,800	2,500

	Mat'l & Frt	Labor
Synchronous Condensers (none)		
Foundations		
8, concrete, for switchyard steel		
= 10 cu yds	400	800
2, concrete, for transformers,		
10' x 14' x 18" = 16 cu yds	640	300
reinforcing steel for above @ 75 lbs/		
cu yd = 1950 lbs	500	200
excavation and backfill for above		
100 cu yds	-	500
Subtotal	$1,540	$1,800
General Station Equipment		
15 outdoor lights	900	900
Platforms, gratings, etc. (incl w/		
switchyard steel)	-	-
Primary and secondary voltage connections		
high voltage leads, 800 lbs	1,000	1,500
control cable (charge to P.P. as it		
ties in with control board)	-	-
power cables, low voltage only (assume		
3000' of 1/c #8 ave)	600	1,800
insulators, etc.	4,000	4,000
AC power distribution panel	400	400
substation steel structures, three		
138kv bays, single bus, no OCB's,		
@ 20,000 lbs/bay = 60,000 lbs	18,000	18,000

		Mat'l & Frt	Labor
gravel fill, 24" deep	1500 cu yds	-	3,000
ground mat, 4,000 lbs		2,000	10,000
Subtotal		$26,000	$38,700
Switchboards (none)			
Switching equipment			
2 - 138kv disconnect switches		10,500	3,000
Tools and appliances			
miscellaneous tools		500	-
	TOTAL	$154,040	$120,940

b. Juneau Substation -

Cost of ground on city dump, 400' x 400'	25,000	
Structures and improvements		
concrete building for Juneau substation, 26' x 119' with 3,096 sq ft @ $22/sq ft (as per Plate 39 in main report. Further foundation investigation may indicate the desirability of using prefabricated metal building. A 4,000 sq ft building was quoted at $63,000 with foundation, insulation, lighting, heating, plumbing and erection, complete by an Anchorage firm)		68,000
TOTAL		$68,000

	Mat'l & Frt	Labor
Station Equipment		
Bus compartments (none)		
Conduit, buried		
69kv bays (4) @ 250' ea of 1" = 1000'		
23kv bays (4) @ 150' ea of 1" = 600'		
Transformer (1) A 200' of 1" = 200'		
Miscellaneous, 1000' of 1" = 1000'		
Subtotal 2800'	1,100	2,000
Cable Trench, concrete, 48" x 48" x 4", 570' = 85 cu yds	2,600	8,400
Reinforcing steel @ 100 lbs/cu yd, 8500 lbs	1,100	900
Steel plate trench cover, 1/4" thick x 5' x 570' = 28,800 lbs	5,700	540
Subtotal	$10,400	$9,840
Control Equipment		
Battery, est. 120 A.H 125v	5,000	2,000
Two chargers, est 20 amps	4,000	1,000
Control board, 8 panels	50,000	6,000
A.C. Power Board	2,500	1,000
D.C. Power Board	2,500	1,000
Six 69kv CTS	9,000	6,000
Six 69kv PTS, 2 bushings	14,000	6,000
Six 23kv CTS	5,000	4,000

	Mat'l & Frt	Labor
Six 23kv PTS, 2 bushings	7,000	4,000
Subtotal	$99,000	$31,000
Conversion Equipment		
Auto transformer, 24/32/40MVA, 138-69-23kv	78,000	8,000
Station service transformer, 110KVA, 24,000-120/240v	1,000	500
Subtotal	$79,000	$8,500
Fences, 1600', 7' high w/3 strand barb wire	8,000	6,500
Synchronous condensers (none)		
Foundations		
10 concrete, for 69kv bays, 3/4 cu yd ea = 7.5 cu yds	250	500
10 concrete for 23kv bays, .61 cu yd ea = 6.1 cu yds	200	500
1 transformer pad, 12' x 20' x 16" = 13 cu yd	400	100
1 station service transformer pad 4' x 6' x 12" = 1 cu yd	50	50
4 pads for intermediate bussing structures, .61 cu yd = 2.5 cu yd	80	200
Reinforcing for above @ 75 lbs/cu yd = 3300 lbs	430	300

	Mat'l & Frt	Labor
Excavation and backfill for above		
100 cu yds	-	500
Subtotal	$1,410	$2,050
General Station Equipment		
Air Compressor (rent, if required)	-	-
Test Equipment	5,000	-
Fault location equipment, 20 lights, outdoor type	1,000	1,000
Subtotal	$6,000	$1,000
Platforms, gratings, etc. (included with switchyard steel)	-	-
Primary and Secondary Voltage Connections		
High voltage leads, 1500 lbs	1,500	2,500
Control cable, 3 to 12/c, #10 & #12, (assume 12,000 ft of 4/c average)	7,000	21,000
Power cables, assume 500' of 500MCM, 600 volt, 1/c, insulated	900	1,000
Small power wiring, assorted, assume 4000' of 1/c #8AWG (ave.) @ 13¢/ft	500	1,500
23kv copper tube bus, 1", 600' insulators, etc.	1,600	1,600
A.C. Power distribution panel	400	400
Substation steel structures		
Four 69kv bays @ 30,000 lbs ea	30,000	30,000

	Mat'l & Frt	Labor
Four 23kv bays @ 8,000 lbs ea	8,000	8,000
One 115kv disconnect switch structure		
@ 2,000 lbs	500	500
Gravel fill, 12" = 6000 cu yds	15,000	6,000
Ground mat, 4,000 lbs	2,000	7,000
Subtotal	$66,400	$79,500
Switchboards with control equipment (none)		
Switching Equipment		
Three 69kv OCB's, 1200 A, 250MVA	95,000	3,600
Ten 69kv disconnect switches	28,000	3,000
Three 23kv OCB's, 600 A, 500MVA	45,000	2,700
Thirty 23kv disconnect switches, 1-pole,		
hook stick operated	6,000	1,000
One 138kv disconnect switch w/grounding		
blade	6,000	1,300
One 138kv high speed grounding switch	4,000	1,000
One 2-pole 23kv fused disconnect switch	400	400
Subtotal	$184,400	$12,400
Tools and Appliances		
Switch Hooks, one 12' and one 16'	100	-
Oil filter and centrifuge	3,000	100
Miscellaneous tools	500	-
Subtotal	$3,600	$ 100
TOTAL	$458,810	$150,890

	Mat'l & Frt	Labor
c. Detailed Estimate, Steel Towers -		
Steel - material, $0.25 x 12,000 x 37	111,000	
labor, $0.25 x 12,000 x 37		111,000
Insulators, suspension 870 @ $7.32	16,700	
Insulators, dead end 1400 @ $7.32		in hdw
Hardware, suspension, material $51 x 29	1,500	
Hardware, suspension, labor $199 x 29		5,800
Hardware, dead end, material $347 x 8	2,800	
Hardware, dead end, labor $303 x 8		2,400
Footings, grouted steel bar:		
material $220 x 37	8,200	
labor $980 x 37		36,300
TOTAL		$290,000
d. Detailed Estimate, Overhead Conductor & Devices -		
795MCM 26/7 ACSR		
material 706,000' x 1.094lbs/ft x $0.38	294,000	
labor 706,000' x 1.094lbs/ft x $0.44		340,000
Overhead Ground Wire *		
material, 2 miles x $1,000	2,000	
labor, 2 miles x $1,000		2,000
Other Devices		
Stockbridge Dampers **		
material, 900 x $13.00	11,700	
labor, 900 x $32.00		28,700
TOTAL		$372,000

* Only 1/2 mile from switchyard, cable terminals and substation
** For estimating purposes 16 lb dampers assumed on long spans and exposed deadends.

	Mat'l & Frt	Labor
e. Detailed Estimate, Submarine Cable -		
Armored Conductors, buried (none)	-	-
Armored Conductors, submarine cable		
250 MCM, 138kv, steel armoed,		
57,000 ft, mfrs quote @ $5.73/ft	327,000	-
Add $0.25/ft for plastic bedding	14,300	-
Freight on 684,000 lbs to Seattle	28,000	-
8 Potheads, 138kv, frt & hndlg	19,000	10,000
8 Oil Reservoirs, fndtn & fence	20,000	4,000
Valve Panel	300	500
3600' of 1-1/2" oil pipe to reservoir	3,200	4,000
2 Cable Terminal Buildings		
150 cu yds concrete, each bldg	9,000	18,000
14,000 lbs reinforced steel, each	3,640	2,800
Insulators, lightning arresters,		
steel stands, pipe	40,000	4,800
138kv leads & jumpers, 120'	120	300
Bonding sheath & armor at low water line	200	500
Insulation under potheads	100	100
Precast Cable Trench, 400'		
Concrete, 80 cu yds	2,400	2,000
Reinforced steel for trench		
@ 150 lbs/cu yd	1,800	1,200
Excavating ditch & placing		
concrete trench	-	1,000

	Mat'l & Frt	Labor
Laying 57,000' of Cable		
Rental of barge from Seattle, 1-1/2 mos.		6,000
Reinforcing barge deck for large reels		5,000
Renting or fabricating 4 large reels (it may be possible to coil cable in hold of barge and eliminate these reels)	4,000	4,000
8 splices, $1,000 each	8,500	10,000
Reeling cable on large drums	-	2,000
Large tug rental, one month	-	20,000
4 small tug rental from Juneau, 2 wks	-	25,000
Driving 4 dolphins, 3 piles each, 500' total @ $8.00/ft	1,000	3,000
Contractor's men from Seattle, assume 10 men for 10 days @ $100/man-day	-	10,000
Local labor, assume 20 men for 10 days @ $75/man-day	-	15,000
Treating oil, filling reservoirs, etc.	7,000	2,000
High potential testing	-	5,000
TOTAL	$489,560	$156,200

SECTION 13

SCHEDULE

FOR

DESIGN

AND

CONSTRUCTION

SECTION 13 - SCHEDULE FOR DESIGN AND CONSTRUCTION

13-01 SCHEDULE FOR DESIGN AND CONSTRUCTION

The weather is the most important controlling factor in scheduling construction of the Snettisham Transmission Line. In the vicinity of Speel Arm the snow remains late; to mid-May or later in spots and the weather becomes quite adverse by October (winds, rain, fog and snow). The best months to accomplish field work are June through September. Around Juneau, the season is longer. The schedule, as shown in Figure 4, calls for the following:

a. Plan, profile, cable terminal surveying and substation terminal surveying all completed by October 1966.

b. Foundations and Materials investigations for the transmission structures, cable terminals, Juneau substation and underwater cable to be completed by October 1966.

c. Design Memorandum No. 9 will be utilizing raw data as it becomes available and is currently scheduled to be finished by December 1966.

d. Plans and specifications will be completed after approval of Design Memorandum No. 9.

e. Right-of-way clearing will start as soon as possible after Design Memorandum No. 9 has been approved. If the right-of-way is cleared at an early date, bidders on the transmission line will have a better opportunity to evaluate construction problems leading to more competitive bids.

f. The submarine cable will be advertised for several months to allow foreign bidding. If the Corps of Engineers' 50 percent policy has not relaxed by that date, it is probable that only domestic manufacturers will bid. The cable takes in excess of 12 months to manufacture and deliver.

The cable may be laid by the manufacturer on a turnkey contract or may be put out on bid to a laying contractor.

g. The construction schedule for the overhead section of the transmission line provides two seasons for completion. If the contractor elects helicopter construction, it may be completed in one season.

h. The construction schedule for the substation provides two seasons for construction. This is more than will probably be required. (Figure 4)

SECTION 14

REFERENCES

SECTION 14 - REFERENCES

14-01 REFERENCE LITERATURE:

Following is a partial list of references used for this study:

(1) Westinghouse Transmission and Distribution Reference Handbook-1950

(2) The Calculation of the Temperature Rise and Load Capability of Cable Systems, J. H. Neher and M. H. McGrath. AIEE Transactions, Vol. 76, Part III, Oct. 1957, p.752-64.

(3) Specifications for Impregnated Paper, Insulated Lead-Covered Cable, Oil-Filled Type, 5th Edition, Jan. 1951, by Association of Edison Illuminating Companies.

(4) Design Standards No. 4, Power Systems, Chapter 4, Transmission Lines, U.S.B.R., May 1961.

(5) Graphic method for sag tension calculations for ACSR and other conductors. ALCOA Aluminum Overhead Engineering Data, Section 8, Aluminum Company of America.

(6) Current-Temperature Characteristics of Aluminum Conductors, ALCOA Conductor Engineering Handbook, Section 6, Aluminum Company of America.

(7) Sag-Tension Computations and Field Measurements of Bonneville Power Administration, Paul F. Winkleman. Power Apparatus and Systems, Feb. 1960.

(8) A Guide to Transmission Structure Design Loadings, F. W. Farr, et al. Power Apparatus and Systems, November 1964.

(9) Standard Specifications and Drawings for Construction of 138 and 161-kilovolt wood-pole, H-frame Transmission Lines. U.S.B.R., October 1960.

(10) Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines. National Bureau of Standards Handbook 81, U.S.D.C., November 1961.

(11) Wind Loads on Overhead Lines (for U.S.S.R.) A. P. Birjulin, V. V. Burgsdorf, B. J. Makhlin, CIGRE, Paris, France, Report 225, 1960.

(12) ALCAN Nechaki-Kemono-Kitimat Development. Reprint from The Engineering Journal, November 1954 and April 1953.

(13) The Mechanical Behavior of Bundled and Single Conductors. New Measurements of Hornisgrinde Testing Station. W. Lerbfried, H. Mors. CIGRE, Paris, France, Report 209, 1960.

(14) Overhead Conductor Vibration, ALCOA Aluminum Overhead Conductor Engineering Data, Section 4. Aluminum Company of America.

(15) Electrical Engineering, August 1964, page 534.

(16) Electric Light and Power, June 1962, page 50.

(17) Electrical West, February 1963, page 40-47.

(18) Electrical West, May 1965, page 23.

(19) Electrical World, 17 August 1959, page 58.

(20) Electrical World, 18 June 1962, page 8.

(21) Electrical World, 25 June 1962, pages 57, 58, 86 and 100.

(22) Electrical World, 30 June 1962, page 44.

(23) Electrical World, 20 August 1962, page 66.

(24) Electrical World, 27 August 1962, page 70.

(25) Electrical World, 3 December 1962, pages 30, 36 and 38.

(26) Electrical World, 7 June 1963, page 25.

(27) Electrical World, 14 June 1963, page 55.

(28) Electrical World, 15 July 1963, page 79.

(29) Electrical World, 12 August 1963, page 112.

(30) Electrical World, 16 October 1963, page 94.

(31) Electrical World, 2 March 1964, page 24.

(32) Electrical World, 18 July 1964, page 72.

(33) Electrical World, 7 September 1964, page 62.

EXHIBITS

EXHIBIT 1

TAKU INLET SEDIMENT SAMPLE ANALYSIS

25 March 1965

Sample No.	Density Lbs/Cu. Ft-Dry	Percent Moisture	Classification
NW-1	83.4	80.4	ML
NW-2	70.0	50.7	ML
NW-3	62.7	48.3	ML
NC-1	41.0	105.6	ML
NC-2	54.8	53.5	ML
NC-3	22.6	22.8	ML
NX-ES #1	98.5	34.0	ML
NX-ES #2	81.8	35.0	ML
NX-ES #3	82.0	35.2	ML
CC-1	48.9	98.6	MH
CC-2	43.6	101.1	MH
CC-3	43.9	97.1	MH
SC-1	44.2	98.8	MH
SC-2	44.6	93.9	MH
SC-3	45.0	90.4	MH
SE-1	83.6	36.3	ML
SE-2	67.4	51.7	ML
SE-3	70.2	44.6	ML
¢X ES #3	76.2	38.9	SM
¢X ES #2	43.6	124.4	SM
¢X ES #1	91.5	31.6	SM
SW-1	69.6	81.6	ML
SW-2	82.9	25.8	SC
SW-3	71.6	40.6	MH
WC-1	52.2	86.8	SM
WC-2	84.2	32.2	ML
WC-3	11.8	286.4	OL

EXHIBIT 2

SELECTED COMPUTATIONS

SNETTISHAM TRANSMISSION LINE

Operation and Maintenance - Roads vs Helicopters, Comparative Analysis

ROAD

Miles of cat trail	26	
Cost/mile	$20,000	
Total Cost	$520,000	
Maintenance @ $100/mi-yr		2,600
Annual cost of capital investment	$520,000 (0.0397)	$20,700
	Annual Cost	$23,300

HELICOPTER

Bell 204B Type - capacity 2800 lbs cabin

or 4000 lbs sling

First Cost	$350,000
Life	10 yrs
Salvage	$50,000
Fuel Consumption	70 gal/hr kerosene
Maintenance	$100/op. hr.

Capital Recovery = 350,000-50,000 (Crf-3-1/8-10) + 0.0313 (50,000)

= $36,760/yr

Hourly cost 70 x $0.25/gal + $100 = $120/flight hr.

EXHIBIT 2 (cont'd)

Snettisham Transmission Line - Roads vs Helicopters

Surplus Helicopter w/$50,000 modifications and reconditioning

0 Salvage

Life 10 yrs

Fuel, maintenance same as above

CR = 50,000 (Crf - 3-1/8 - 10) = $5,900/yr

Assumption of use

Summer, 4 mos. @ 4 hrs/day @ 2 das/mo = 32 hrs

Winter 8 hrs

40 hrs/yr

Annual Cost

New Machine

First Cost	$36,760
Maintenance & fuel (120 x 40)	4,800
Pilot (part time)	1,000
	$42,560/yr

Surplus Machine

First Cost	$5,900
Maintenance & fuel (120 x 40)	4,800
Pilot	1,000
	$11,700/yr

EXHIBIT 2 (cont'd)

Snettisham Transmission Line - Roads vs Helicopters

Road Equipment Costs for Pole Work/yr

Equipment	Life	First Cost	Salvage	Use/yr
D-6 w/winch	10 yrs	25,000	5,000	180 hrs
Line Truck	5 yrs	9,000	1,000	25 hrs
Barge	15 yrs	50,000	5,000	200 hrs

Cat Cost/yr

CR = ($25,000 - 5,000)(Crf - 3-1/8 - 10) + 5,000 (0.0313)

= 2,517/yr

Truck Cost/yr

CR = ($9,000 - 1,000)(Crf - 3-1/8 - 5) + 1,000 (0.0313)

= $2,000/yr

Cat Fuel Cost and Maintenance

$5/yr x 180 = $900/yr

Truck Fuel Cost and Maintenance

$4/hr x 25 = $100/yr

Landing Barge Costs

Assume barge not required for other purposes - charter boats available

CR = ($50,000 - 5,000)(Crf - 3-1/8 - 15) + 5,000 (0.0313)

= $3,956/yr

Fuel Cost $4/hr + $1 oil

Maintenance $3/hr

Cost/yr 200 x $8/hr = $1,600/yr

EXHIBIT 2 (cont'd)

Snettisham Transmission Line - Maintenance of Roads vs Helicopters

Outage Calculations

Maintenance of line break near Taku Inlet

	Description	Roads min.	Helicopter min.
(1)	Scout line and report	40	0
	Load	30	10
	Run to site	180	15
	Clear snow move equipment 1 mi	60	0
	(Repair)	same	same
	Move equipment back	20	0
	Load	10	10
	Run	180	15
	Unload	30	10
	Total	550	60
		9 hrs - 10 min	1 hr

Duration of outage (1) = 310 min

T = 310 - 25 = 285 min

= 285/60 = 4 hrs 45 min

Value of T @ $8,610/day

$8,610 x 4.75/24 = 1,700/outage

Additional Labor and equipment time 8.16x$40/hr 330

2,030

Use 2,100

EXHIBIT 2 (cont'd)

Snettisham Transmission Line - Maintenance of Roads vs Helicopters

Comparative Costs

Description	Helicopter $/yr	Road $/yr
Road and maintenance		22,300
Helicopter, large	42,560	--
Helicopter Hiller 12E ($100/hr for areas where there are no roads)	3,000	5,000
Cat		3,400
Truck		2,100
Barge		4,600
Additional transport time (3 men 1 hr/day @ $10/hr for 80 hrs/yr)		2,400
Additional labor time to move poles to roadless spots by winch (beyond Hiller 12E capacity)		3,000
6 poles/yr @ $500/pole		
Subtotal	$45,560	$42,800
Additional cost for 1 outage per year of road		2,100
	45,560/hr	44,900/yr
Savings road over helicopter	660/yr loss	
If surplus helicopter used	14,700	44,900/yr
Savings of helicopter over roads	$29,200/yr	

AD-A067 895 CORPS OF ENGINEERS ANCHORAGE AK ALASKA DISTRICT F/G 13/2
SNETTISHAM PROJECT ALASKA. FIRST STAGE DEVELOPMENT. DESIGN MEMO--ETC(U)
OCT 65

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EXHIBIT 2 (cont'd)

Snettisham High and Low Line Comparison

PROSPECT POINT TO CIRCLE POINT

Data: Voltage 138kv

Conductor 26/7 795MCM ACSR

Line Data:	High Route	Low Route
Length, feet	58,600	103,650
Length, miles	11.08	19.60
Wood pole length, miles	5.63	19.00
Steel Tower length, miles *	5.47	-
Angle Structures	37	32

Assumptions:

Tower Weights, 12,100 lb avg

Footings, grouted bars

Steel Cost, $0.60/lb erected

O & M Cost/mi, $20,200 PW

* Steel towers used in those areas above 2000 foot elevation.

EXHIBIT 2 (cont'd)

Snettisham High and Low Line Comparison

Description	High Line $	Low Line $
Towers, 58 x $8,460	491,000	
Insulators, steel section	17,320	
Wood Poles *, $21,800 x 5.63	123,000	
$21,800 x 19.60		428,000
Conductor, wood section, $14,200 x 5.63	80,000	
$14,200 x 19.60		278,000
Conductor, steel section, $16,200 x 5.47	88,500	
Clearing, steel section	0	
Clearing, wood $7,750 x 5.47	43,600	
$7,750 x 19.60		151,700
Losses, Present Worth, $12,300 x 11.08	136,500	
$12,300 x 19.60		242,000
Subtotal	979,920	1,099,700
O & M, Present Worth **		
$20,200 x 11.08	224,000	
$20,200 x 19.60		396,000
Interim Replacement ** 0.2% x 25.13 = 5.02		
0.0502 x 676,820	34,000	
0.0502 x 706,000		36,000
Subtotal	1,237,920	1,531,700

* Includes guys, insulators, etc.
** Same values of steel as wood due to adverse conditions

EXHIBIT 2 (cont'd)

Snettisham High & Low Line Comparison

Description		High Line	Low Line
Outage Value			
	(4)(8,610)(25.13)	865,000	
	(1)(8,610)(25.13)		216,000
GRAND TOTAL		$2,103,000	$1,748,000
Difference	$355,000		

CHEROKEE FLATS TO THANE

Data: Voltage 138kv

Conductor 26/7 795MCM ACSR

Miles HL = 6.36 LL = 6.77

Description:		High Line	Low Line
Wood Poles,*	$21,800 x 1.5 x 6.36	207,000	
	$21,800 x 6.77		147,000
Conductor,	$16,200 x 6.36	103,000	
	$14,200 x 6.77		96,000
Clearing,	$ 7,750 x 6.77	0	52,300
Losses, Present Worth,	$12,300 x 6.36	78,200	
	$12,300 x 6.77		83,200
O & M Present Worth,	$20,200 x 6.36	128,000	
	$20,200 x 6.77		137,000

* Includes guys, insulators, etc.

EXHIBIT 2 (cont'd)

Snettisham High and Low Comparison

Interim Replacement	0.0502 x $310,000	15,000	
	0.0502 x $243,000		12,000
Subtotal		531,000	528,000
Outage Value **		216,000	0
GRAND TOTAL		$747,000	$528,000

Difference $219,000

**VALUE OF OUTAGE IN POWER SALES

Most Probable Period:

Month	%KWH/mo	days/mo.	%/day
Dec	9.70	31	0.313
Jan	8.96	31	0.289
Feb	8.13	28	0.291
Mar	8.38	31	0.270
			1.163

$$4\,\overline{)1.163}\quad 0.291/\text{day}$$

KWH/day

$0.291/100 \times 328.3 \times 10^6$ KWH 957,000 KWH

@ 9 mills = $0.009 x 957,000 = $8,610/day

EXHIBIT 2

SELECTED COMPUTATIONS

Formula for Computing Losses

Computation of Formula for I^2R losses on conductor and cable:

B	=	average power
X	=	some increment the load curve varies from B
K	=	some constant composed of resistance and voltage which can be multiplied by kilowatts squared to give losses
n	=	number of records used
K'	=	X/B

$$\text{Average loss} = KB^2 \left[1 + \frac{2}{n} \sum_{J=1}^{J=n} K_J^1 + \frac{1}{n} \sum_{J=1}^{J=n} K'^2_J\right]$$

This formula allows the use of any load curve shape with any base power amount for any voltage. It was computed for the Juneau load curve and used on the Snettisham transmission computations and gave a figure of approximately 9 percent increase (value inclosed in brackets) for the base I^2R which is the result of KB^2.

EXHIBIT 3

UNITED STATES
DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

ALASKA DISTRICT HEADQUARTERS
P. O. BOX 2567. JUNEAU. ALASKA

IN REPLY
REFER TO: 640

November 6, 1964

District Engineer
U.S. Army Engineer District, Alaska
P.O. Box 7002
Anchorage, Alaska 99501

Re: NPAEN-PR-R

Dear Sir:

We are agreeable to your proceeding with procurement of the following described work boats for use at the Snettisham Project, as discussed with representatives of your office:

1 - Landing Craft capable of ferrying a line truck, D-8 tractor, materials and associated personnel.

1 - Materials and Supplies Boat of the 40 to 50 foot, 20-knot class, twin diesel powered engines, ice resistant hull, and a seaworthy design to enable use in high rough seas.

As mutually agreed, craft of the above description shall be procured by the U.S. Army Engineer District, Alaska. They will be used by Corps of Engineer personnel during the design and construction phases of the project and later turned over to the Bureau of Reclamation for operation and maintenance use. During the transition period from construction to operation of the project, interagency coordination for joint use of the boats will be required.

The following evaluation of O & M costs for the transmission line over the high mountain pass route compared to the sea level route are submitted for cost comparison purposes only:

High Pass Route (Slocum Inlet-Mallard Cove)

	Miles	Construction Cost	Replacement	O & M
Steel Towers & Fixtures	5.0	1,260,000	$ 649	$2,150
Wood Pole & Fixtures	5.5	103,000	471	1,210
			$1,120	$3,360
Total OM&R			$4,480	

EXHIBIT 3

Sea Level Route (Slocum Inlet-Mallard Cove)

	Miles	Construction Cost	Replacement	O & M
Steel Towers & Fixtures	0	0	0	0
Wood Pole & Fixtures	18.5	346,000	$1,580	$4,070

Total OM&R $5,650

Average loss of revenue due to one 24 hour outage =
730,000 kwh/day x $.008/kwh = $5,840/day

Line damages which would require possibly one day to repair on the sea level routing could require 2 or more days to repair on the high-pass routed line. In addition, we estimate that outage frequency will be at least double on the high pass route or an outage ratio of 4 to 1 for the two routes. The loss in revenue annually, therefore, would be 4 days x $5,840 per day = $23,360 on the high pass route. This compares to the related one day revenue outage loss of $5,840 and the additional annual OM&R cost of $1,170 for a total of $7,010 for one severe line outage per year on the sea level route. The net difference in OM&R and potential revenue loss between the two routes is $16,350 annually, which has a present worth value of $460,320 if paid annually, for fifty years at 2.5% interest.

We trust that the above evaluation, together with the information you have received from the Forest Service, will enable you to complete your study of the relative economics of the alternative routes.

Unfortunately, it is not possible to place a monetary value on the personal hardships and business losses which will be incurred in the Greater Juneau-Douglas area if extended outages are experienced on the Snettisham transmission line. These are very serious intangibles, however, and certainly favor the Sea Level Route.

Sincerely yours,

Geo. N. Pierce

George N. Pierce
District Manager

cc: Chief Engineer, Attn: D240/D-600
Commissioner, Attn: 600

EXHIBIT 3

TABLES

EXPLANATIONS OF TABLE 1

ECONOMIC ANALYSIS - OVERHEAD LINE SECTION

(1) Voltages were chosen from 69kv to 230kv to absolutely cover the entire range of feasible voltages.

(2) The current is shown for each voltage at 77MVA load. This load is equal to the 69MW plant overload capacity divided by a 0.9 power factor.

(3) Conductors are aluminum cable, steel reinforced. Sizes were chosen for study which were estimated to bracket the most economical size. On the 138kv, 161kv and 230kv tabulations, the minimum size shown is the minimum size which can be used due to corona loss limitations.

(4) The current capacity of each conductor is from Ref 1, page 50.

(5) Conductor weights are for 134 miles of single phase conductor and are taken from Ref 1, page 50.

(6) Conductor material costs - a price of .38¢/lb was used for this study. This is approximate catalog price plus freight.

(7) Labor Cost - CEA prices for 556.5MCM (1.1 million lbs) was .69¢/lb total in 1959 and 1962. At .38¢ material cost, labor was .31¢/lb. At Snettisham, due to the rougher terrain, it was assumed that stringing would be a greater percentage of conductor material cost and stringing costs were increased by approximately 40 percent over CEA prices. An estimating graph, Figure 5, was made to take into account the variation in stringing cost per pound with changes in conductor size.

(8) Cost of Structures - It was assumed that a steel tower section runs 5.3 miles from the powerplant and wood pole H-frame construction continues from this point into Juneau, except for the 2.7 mile submarine cable crossing, making 39.3 miles of wood pole line. The weights of standard steel towers used on the coast were used to arrive at the following tons per mile. The installed cost of towers on the west coast has been around 25 to 30 cents per pound and one job by Chugach Electric Association in Anchorage, in 1962 with 9 special towers, cost 81 cents per pound. Since we will have about 37 towers, more or less standard, an installed price of 50 cents per pound has been used.

	Tons/Mile	Cost
69kv	26	$138,000
115kv	28	148,000
138kv	29	154,000
161kv	30	159,000
230kv	32	170,000

In addition to the steel erection costs, a figure of $1,200 per structure for tower footings has been added. For 37 structures, this adds a cost of $45,000. It is expected that a large percentage of the footings can be reinforcing bars grouted into drilled holes in the rock. Where rock is not near the surface, a dug hole with a steel plate type footing will be used. A profile along 10 miles of the route of the wood pole line was roughed out using the contours as shown on Plate 5. Structures were spotted and conductor was drawn in using a sag template for 795MCM ACSR and ground clearances specified by the U. S. Bureau of Reclamation. A takeoff was then made of the heights and types of structures required for all voltages, taking into account different ground clearances, lengths of insulator strings and depths of pole settings. The cost for each type and height of structures was estimated by escalating by 9 percent the prices paid by Chugach Electric Association in 1962 on their 115kv line. The costs of the other voltage lines were adjusted by the installed cost differences for crossarms, X-braces, and insulator strings. U. S. Bureau of Reclamation standard HS suspension structures on tangent sections and three-pole dead-end structures at all turn points were assumed.

(9) Clearing Costs - Clearing cost data was taken from the 115kv line of Chugach Electric Association built in 1962. Their clearing cost was $425.00 per acre in the most densely wooded areas. Snettisham clearing costs are estimated at 50 percent more than this because of the less accessible terrain. The clearing widths assumed are 80 ft for 69kv, 100 ft for 115kv and 138kv, 110 ft for 161kv and 125 ft for 230kv. Also, since there are numerous rocky areas, canyons and water crossings where clearing is not required, the total length is assumed as 40 miles for calculating acreage.

(10) Total Construction Costs - The total construction costs are the sum of Columns 6, 7, 8 and 9. These costs are estimated for relative comparison of different schemes and should not be considered as detailed cost estimates.

(11) - (14) Present Worth of Losses - Losses during first 13 years when water is spilled have no value. After the 13th year with 331 million kilowatt-hour per year delivery, average kva is 42,000 at 0.9 P.F. and I^2R losses are based on this kva with the effect of charging current. These losses have been calculated for each of loading assumptions A, B, C and D. Under assumption A, no load growth after 14th year, the sum of the value of the losses for 37 years is 21.75 times the yearly losses. Under assumptions B, C and D, the present worth is the sum of the products of two diverging series. The losses are increasing as the square of the current and the present worth value of the losses is declining, as they occur further and further in the future. Under any of these assumptions only a multiplying factor is necessary to convert the losses from assumption A. The formula for calculating present worth loss factor K_s is as follows:

$$K_s \left[\frac{(1 + r)^2}{1 + i} - 1 \right] = \frac{(1 + r)^{2n}}{(1 + i)^n} - 1$$

where r = rate of load growth
i = interest rate, in this case 3-1/8%
n = number of years in series

The loss factors for the different assumptions are as follows:

	K_s	Ratio of PW's
A	21.75	1.0
B	64.60	2.97
C	-	4.95
D	-	3.86

(15) Present Worth of Interim Replacements - The Federal Power Commission Technical Memorandum No. 1, "Instructions for Estimating Electric Power Costs and Values," dated April 1, 1960 recommends interim replacement factors of 0.20% for wood pole transmission lines and 0.10% for steel tower lines. A .20% factor has been assumed on this line to give an additional allowance for more severe condition at Snettisham. Clearing costs are not included in the line costs.

(16) Present Worth of O & M Costs - These costs can vary considerably depending upon the method of transportation utilized for moving men and equipment. If a new, large helicopter is purchased for $350,000, the yearly cost is estimated at $21,280 for helicopter debt service and operation, $3,000 for renting a small copter, $1,000 for spraying, $1,000 for materials and $10,000 for labor, making a yearly cost of $36,280, say $36,000. This figure assumes that half the cost of the large copter is charged against investigations. If a used large helicopter is procured and reconditioned for $50,000, the total yearly cost falls to approximately $23,000. If roads are built where economically feasible, a small copter used for wintertime patrolling and a large copter flown in for any heavy lifting for emergencies in inaccessible areas, the yearly cost becomes $22,300 for road debt service and maintenance, $5,000 for small helicopter rental, $2,000 for spraying, $1,000 for materials, $10,000 for ground equipment debt service and operation, and $12,000 for labor, making a total of $52,300, say $52,000. Debt service and maintenance for roads is included in this calculation since it appears quite probable that this line could be built by helicopter without any appreciable roads. Since the roads would then be built solely for O & M, their capital recovery and maintenance costs can properly be charged to this account. For the purpose of this study, a small variation in cost was assumed for different voltages to reflect differences in material, labor and spraying costs. The yearly costs assumed are for operation with a new large copter as follows:

Voltage (kv)	Cost/year
69	$34,000
115	35,000
138	36,000
161	37,000
230	38,000

(17) - (20) Total Present Worth - These columns represent the comparative 50-year costs of the different voltages and conductors under each of the four loading assumptions.

TABLE 1

ECONOMIC ANALYSIS - OVERHEAD LINE SECTION

KV	Current @ 77 MVA (Amp)	CONDUCTOR Size (MCM)	CONDUCTOR Cap'y (Amp)	CONDUCTOR Weight for 134 mi. (M/lbs)	CONDUCTOR Mat'l Cost (M/$)	CONDUCTOR Labor Cost (M/$)	Struct. Costs (M/$)	Clear'g Costs (M/$)	Total Const Costs (M/$)	PRESENT WORTH OF LO UNDER ASSUMPTIO A (M/$)	B (M/$)	C (M/$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
69	654	795	900	772	294	340	797	248	1679	2300	6830	11400
69	654	954	1010	867	330	373	817	248	1768	1950	5800	9650
69	654	1192.5	1160	1080	410	464	837	248	1959	1540	4570	7620
115	387	266.8	460	242	91	193	868	310	1462	2500	7430	12350
115	387	636	780	619	235	303	878	310	1726	1050	3120	5200
115	387	795	900	772	294	340	888	310	1832	840	2500	4150
115	387	954	1010	867	330	373	908	310	1921	710	2110	3510
115	387	1192.5	1160	1080	410	464	928	310	2112	580	1720	2870
138	322	266.8	460	242	91	193	942	310	1536	1650	4900	8170
138	322	477	670	464	176	265	952	310	1703	930	2760	4600
138	322	636	780	619	235	303	962	310	1810	690	2050	3420
138	322	795	900	772	294	340	972	310	1916	550	1630	2720
138	322	954	1010	867	330	373	992	310	2005	462	1370	2290
138	322	1192.5	1160	1080	410	464	1012	310	2196	371	1100	1840
161	276	397.5	590	386	147	255	1084	341	1827	800	2370	3960
161	276	556.5	730	540	205	286	1094	341	1926	570	1690	2820
161	276	954	1010	867	330	373	1125	341	2169	335	995	1660
161	276	1192.5	1160	1080	410	464	1155	341	2365	269	798	1330
230	194	666.6	800	606	230	291	1182	388	2091	240	713	1190
230	194	954	1010	867	330	373	1215	388	2306	167	496	826

ES	PRESENT WORTH		TOTAL PRESENT WORTH OF LINE UNDER ASSUMPTION			
D	Interim Replact	O&M	A	B	C	D
(M/$) (14)	(M/$) (15)	(M/$) (16)	(M/$) (17)	(M/$) (18)	(M/$) (19)	(M/$ (20)
8850	68	853	4900	9430	14000	11480
7530	71	853	4642	8492	12342	10222
5940	80	853	4432	7462	10512	8832
9650	56	878	4886	9816	14736	12036
4050	68	878	3722	5792	7872	6722
3240	72	878	3622	5282	6932	6022
2740	76	878	3585	4985	6385	5615
2240	82	878	3652	4792	5942	5312
6370	60	904	4150	7400	10670	8870
3590	67	904	3604	5434	7274	6264
2660	72	904	3476	4836	6206	5446
2120	77	904	3447	4527	5617	5017
1790	80	904	3451	4359	5279	4779
1430	89	904	3560	4289	5029	4619
3090	72	928	3627	5197	6787	5917
2200	76	928	3500	4620	5730	5130
1290	88	928	3520	4180	4845	4475
1030	96	928	3658	4187	4719	4419
926	82	953	3366	3839	4316	4052
645	92	953	3518	3847	4177	3996

TABLE 1

EXPLANATION OF TABLE 2

ECONOMIC ANALYSIS -- SUBSTATIONS

Prices on substation equipment were obtained from manufacturers catalogs and manufacturers representatives. Current prices on complete switchyard bays at different voltages were obtained from the Estimating Section of the Denver office of the Bureau of Reclamation. This tabulation is not a detailed cost estimate but primarily a comparison study with items being included which change in cost with changes in voltage. The following paragraph numbers correspond to the line numbers on the table:

JUNEAU SUBSTATION:

(1) Four 69kv Bays with OCB's - Four bays are required only for the case where incoming line is 69kv since a bay will be required for the incoming line. The Bureau's figure of $64,000 per bay has been escalated 25 percent for Alaskan conditions, 10 percent for overhead, 5 percent for freight and 10 percent for contingencies, for a total of 50 percent.

(2) Three 69kv Bays with OCB's - At 115kv and above, the incoming line would initially be run directly to the step down transformer as shown on Figure 2, "Switching Diagram." This, then requires only three OCB bays. These figures are Bureau estimates escalated by 50 percent.

(3) One 69kv Bay with one disconnect - This transfer bay is required in all schemes to allow switching of load from main bus to transfer bus for maintenance purposes. Cost of OCB and two disconnect switches was deducted from above full bay prices and 50 percent added to arrive at these figures.

(4) One disconnect switch with grounding blade - This switch is required only on schemes above 69kv. The figures include escalated cost of the switch plus $10,000 to cover cost of switch supporting structure and foundation.

(5) Three 23kv Bays with OCB's - The Bureau's figure of $39,000 per bay has been escalated by 50 percent.

(6) One 23kv Bay with one disconnect - Catalog cost of one OCB and two disconnect switches has been deducted from the Bureau's figure of $39,000 and remainder escalated by 50 percent.

(7) One 69-23kv Transformer - This 9/12/15MVA transformer would be required only in the case where transmission line is 69kv. Catalog price of $46,000 includes 200kv low side BIL, western zone delivery, bushing current transformers, lightning arresters and extra creep bushings. Transformer price is escalated 30 percent for freight, overhead and contingencies and $10,000 added for installation.

(8) Transformer, 24/32/40MVA - These prices were taken from manufacturer's catalogs including the features in 7 above. The transformer price is escalated 30 percent also and $10,000 added for installation. The 115 and 138kv schemes are priced with autotransformers.

(9) Building, Control Equipment, etc. - A 40 by 100 foot building is assumed to allow space for a control room, office, warehouse and garage areas. At $15 per square foot this is $60,000. An eight panel control board is $40,000 in purchase price. Accessory equipment, such as station transformers, battery, AC and DC boards, etc. are estimated at $30,000. Labor on installation of control boards, battery and power boards, etc. is estimated at $25,000.

(10) Utilities and Improvement - The cost of fencing, grading, utilities, etc. is estimated at $40,000.

(11) Cables, Conduits and Miscellaneous - This item covers cost of minor conduit and cable work and miscellaneous items not covered in 9 above.

(12) Juneau Substation Total - This is the substation cost with the use of autotransformers on 115 and 138kv.

SNETTISHAM SWITCHYARD:

(13) Two Transformers-26MVA - These transformer prices are from manufacturer's catalogs and include bushing CT's, high side lightning arresters, western zone delivery and extra creep high side bushings. The figure in this line includes 30 percent escalation plus $5,000 each for handling to site.

(14) Two Disconnect Switches - These figures include the catalog prices of the switches escalated by 100 percent.

(15) Switch and Takeoff Structure - These figures cover cost of steel switch support and line takeoff structures.

(16) Labor, Overhead, Contingencies, Profit - These figures cover costs of above items, including $10,000 for installation of each transformer. No items on low voltage side of the transformers are included.

(17) Cable, Conduit, Miscellaneous - These figures include high side bussing, connections to CT's and all control, indication, protection and annunciation required for the transformers.

(18) Snettisham Switchyard Total - These are total comarative costs of the switchyard.

(19) Second Juneau Transformer - It is assumed that the second transformer will be required on the 69kv scheme. On the 115 to 230kv plans, the

second transformer is assumed to be paralleled with the first transformer and disconnect switches only provided for isolating purposes to keep down costs. In addition to transformer and disconnect switch costs, $10,000 has been added for the control, relaying and metering installation.

(20) Present Worth of 2nd Transformer - This is the above figure present worthed to 1969.

(21) Crater Lake Switchyard Addition - It is assumed that the third unit will be added in 1980, the two year delay being possible by using existing capacity in Juneau, and the fact that camp and station loads do not go through the transformers, the power factor will be near unity and peak loads occur when the ambient temperature is low. The figures are 50 percent of the cost of the initial two unit installation.

(22) Present Worth of Crater Lake Addition - This figure is the above figure present worthed to 1969.

(23) Present Worth Total - This is the sum of the Juneau Substation, Snettisham Switchyard and present worth costs of the second Juneau Transformer and the Crater Lake Switchyard addition.

TABLE 2

ECONOMIC ANALYSIS - SUBSTATIONS

Item		VOLTAGE (KV) 69	115	138	161	230
	JUNEAU SUBSTATION					
(1)	Four 69kv Bays with OCB's	$384,000	-	-	-	-
(2)	Three 69kv Bays with OCB's	-	$288,000	$288,000	$288,000	$288,000
(3)	One 69kv Bay with disconnect switch only	43,000	43,000	43,000	43,000	43,000
(4)	One disconnect switch with ground blade	-	17,000	18,000	19,000	27,000
(5)	Three 23kv Bays with OCB's	175,000	175,000	175,000	175,000	175,000
(6)	One 23kv Bay with disconnect switch	34,000	34,000	34,000	34,000	34,000
(7)	One 69-23kv Transformer	70,000	-	-	-	-
(8)	Transformer, 24/32/40 MVA	-	101,000	104,000	168,000	204,000
(9)	Building, control, etc.	155,000	155,000	155,000	155,000	155,000
(10)	Utilities & Improvement	40,000	40,000	40,000	40,000	40,000
(11)	Cables, conduit, miscellaneous	10,000	10,000	10,000	10,000	10,000
(12)	JUNEAU SUBTOTAL	$911,000	$863,000	$867,000	$932,000	$976,000
	SNETTISHAM SWITCHYARD					
(13)	Two Transformers (26 MVA)	$165,200	$183,000	$184,000	$201,000	$262,000
(14)	Two Disconnect Switches	11,600	19,200	22,600	22,600	30,000
(15)	Switch and Takeoff Structure	5,000	6,000	7,000	8,000	10,000
(16)	Labor, Overhead, Contingencies, profit	30,000	32,000	34,000	36,000	40,000
(17)	Cable, Conduit, miscellaneous	15,000	16,000	17,000	18,000	20,000
(18)	SNETTISHAM TOTAL	$226,800	$256,200	$264,600	$285,600	$362,000
(19)	2nd Juneau Transformer - 1976	$138,000	$128,000	$132,000	$197,000	$241,000
(20)	Present Worth - 2nd Transformer	111,000	103,000	106,000	159,000	194,000
(21)	Crater Lake Switchyard Addition - 1980	114,000	130,000	134,000	144,000	181,000
(22)	Present Worth - Switchyard Addition	81,000	93,000	96,000	103,000	129,000
(23)	PRESENT WORTH TOTAL	$1,329,800	$1,315,200	$1,333,600	$1,479,600	$1,611,000

TABLE 3

3A or 3AB STRUCTURE COSTS

3AB or 3A Structures - Single Insulator String

All Costs - $1,000

Length Class Poles	No. Strct	Cost/ Strct $	Pole Hdw + Labor $	Pole Hdw Total $	Excav + Bckfl $	Excav Total $	Poles $	Poles Total $	Setting $	Setting Total $	Guys $	Guys Total $
55-1	16	4.303	.200	3.2	.483	7.73	.447	7.16	.180	2.88	1.200	19.20
60-1	8	4.533	.210	1.68	.594	4.74	.516	4.12	.180	1.44	1.230	9.83
65-1	8	4.743	.210	1.68	.687	5.49	.603	4.82	.210	1.68	1.230	9.83
85-1	4	6.343	.230	0.92	1.569	6.27	1.101	4.43	.330	1.32	1.290	5.16
3AB or 3A Structures - Double Insulator Strings												
70-1	4	5.466	.220	0.88	.855	3.42	.705	2.82	.240	0.96	1.260	5.03
75-1	4	5.827	.220	0.88	1.058	4.23	.833	3.33	.270	1.08	1.260	5.03
TOTALS	44			$1.76		$7.65		$6.15		$2.04		$10.06

nchors $	Anchors Total $	INS $	INS Total $	INS Hdw + Labor $	INS Hdw + Labor Total $
1.400	22.40	.218	3.49	.175	2.80
1.400	11.20	.218	1.74	.185	1.48
1.400	11.20	.218	1.74	.185	1.48
1.400	5.6	.218	0.87	.205	0.82
1.400	5.6	.436	1.74	.350	1.4
1.400	5.6	.436	1.74	.350	1.4
	$11.20		$3.48		$2.80

GRAND TOTAL = $213,540

TABLE 3

2

TABLE 4

3T STRUCTURE COSTS

3T Structure - Single Insulator String

All Costs - $1,000

Length Class Poles	No. Strct	Cost/ Strct $	Pole Hdw + Labor $	Pole Hdw Total $	XArms Labor + Mat'l $	XArms Total $	Excav + Bckfl $	Excav Total $	Poles $	Poles Total $	Settings $	Sttng Total $
50-1	4	5.123	.216	.86	.370	1.48	.410	1.64	.371	1.48	.150	.60
55-1	4	5.302	.216	.86	.370	1.48	.483	1.93	.447	1.79	.180	.72
70-1	12	6.612	.226	2.72	.380	4.56	.795	9.55	.705	8.46	.240	2.88
70-1	8	7.071	.336	2.68	.380	3.04	.855	6.83	.705	5.63	.240	1.92

3T Structure - Double Insulator Strin

Length Class Poles	No. Strct	Cost/ Strct $	Pole Hdw + Labor $	Pole Hdw Total $	XArms Labor + Mat'l $	XArms Total $	Excav + Bckfl $	Excav Total $	Poles $	Poles Total $	Settings $	Sttng Total $
90-1	4	9.101	.346	1.38	.400	1.6	1.935	7.83	1.155	4.61	.360	1.44
TOTALS	32			$8.50		$12.16		$27.78		$21.97		$7.56

1

XBrace $	XBrce Total $	SGuys $	SGuys Total $	Anch $	Anch Total $	INS $	INS Total $	INS Hdw + Lab $	INS Hdw Total $
.290	1.16	.880	3.52	1.400	5.6	.610	2.44	.426	1.7
.290	1.16	.880	3.52	1.400	5.6	.610	2.44	.426	1.7
.290	3.48	.920	11.05	1.400	16.8	.610	7.32	.446	5.35
		Dbl Guys	DGuy Total						
.290	2.32	1.260	10.01	1.400	11.2	.953	7.62	.652	5.21
.580	2.32	1.320	5.28	1.400	5.6	.953	3.81	.652	2.61
	$10.44		$33.38		$44.80		$23.63		$16.57

GRANT TOTAL $206,790

TABLE 4

2

TABLE 5

HS STRUCTURE COSTS

ALL COSTS $1,000

Length Class	No. Strct	Cost/ Strct $	Poles Hdw & Labor $	Xarms Labor + Mat'l $	Xarms Total $	Excav Bckfl $	Excav Total $	Poles $	Poles Total $	Sett $
45-1	35	1.520	5.95	.217	7.6	.259	9.08	.205	7.05	.1
50-1	20	1.580	3.4	.217	4.34	.273	5.46	.245	4.90	.1
55-1	47	1.700	8.00	.217	10.20	.321	15.1	.298	14.0	.1
60-1	75	1.850	12.75	.227	17.00	.396	29.6	.344	25.8	.1
65-1	35	1.990	5.95	.227	7.93	.458	16.0	.402	14.1	.1
70-1	24	2.220	4.08	.237	5.69	.530	12.7	.470	11.3	.1
75-1	16	2.600	2.72	.237	3.79	.705	11.25	.555	8.88	.1
85-1	8	3.190	1.36	.247	1.97	1.046	8.37	.734	5.87	.2
90-1	4	3.520	0.68	.257	1.03	1.290	5.16	.770	3.08	.2
TOTALS	264		$44.89		$59.55		$112.72		$94.98	

;s	Settings Total $	XBraces $	XBraces Total $	INS $	INS Total $
	3.50	.145	5.07	.426	14.9
	2.0	.145	2.9	.426	8.52
	5.63	.145	6.81	.426	20.00
	9.0	.145	10.85	.436	32.70
	4.9	.145	5.07	.436	15.30
	3.84	.145	3.48	.446	10.70
	2.88	.290	4.64	.446	7.14
	1.76	.290	2.32	.456	3.65
	0.96	.290	1.16	.466	1.78
	$34.47		$42.30		$114.69

GRAND TOTAL = $503,600

TABLE 5

2

EXPLANATION OF TABLE 6

ECONOMIC ANALYSIS - SUBMARINE CABLE

The following numbered paragraphs correspond with the column numbers in the table.

(1) Voltage - Only 115, 138 and 161kv cables were chosen for study. Since the present worth cost of the cheapest 69kv overhead conductor was approximately one million dollars more than the higher voltages under loading assumption A, no further consideration was given to this voltage. The 230kv cable was also excluded because the excessive charging current would require investment in reactive control equipment and the 230kv cable material cost would be at least $250,000 more than the lower voltage cables.

(2) Armor - Cable armor types selected for this study were No. 4 AWG aluminum alloy and No. 4 and No. 6 BWG steel wire.

(3) Conductor Size - Minimum conductor sizes were selected to carry 77MVA or more.

(4) Material Cost - Cable and accessory terminal equipment costs were received from Phelps-Dodge Copper Products Corp. for 115 and 138kv. Prices on the cable only were also received from them for 161 and 230kv cable. The figures in this column include the cable and terminal equipment costs, $30,000 for freight to Juneau, $0.25 per foot for substituting plastic bedding in place of jute, and construction material costs for each terminal as follows:

115kv ------------------------	$20,000
138kv ------------------------	$22,000
161kv ------------------------	$25,000

The terminal price estimates include precast concrete cable trenches, an enclosing building for the potheads to protect them from salt water spray, piping and a transmission line takeoff structure, either integral with the building or separate.

(5) Labor Cost - The labor cost estimate for constructing the terminals, splicing the cable, laying and testing is as follows:

a.	Splicing cable and rereeling ------------------	$ 40,000
b.	Reinforcing barge deck, etc. ------------------	5,000
c.	Barge rental, 1 month -------------------------	4,000
d.	Tug rental from Seattle, 500 H.P., 1 month ------	20,000
e.	Rental for 4 tugs, from Juneau, 2 weeks ---------	25,000
f.	Contractor's labor, assume 10 men from outside for 25 days @ $100/man-day ------------------	25,000

g. Local labor, assume 20 men for 10 days @ $75/man-day		$ 15,000
h. Additional labor on two terminals		26,000
	TOTAL	$ 160,000

Above tug and barge costs are based on estimates received from the Alaska Tug and Barge Company on 24 September 1965.

(6) Initial Cost - This is the sum of columns 4 and 5.

(7) Yearly Cost - 30-Year Life - The cable is assumed to have a life of 30 years and the figures in this column represent the yearly capital recovery cost.

(8) Present Worth on 50-Year Life - In order to compare all costs in this study on a uniform basis, the yearly costs in Column 7 have been converted to a 50-year present worth figure.

(9) Losses per year-KWH - The cable losses per foot are shown in Table 7, "Submarine Cable Loss Tabulation." The figures in this column include all losses on the three cables which are in active use plus the insulation loss only on the spare cable, which is assumed to be continuously energized. These losses are based on assumption A.

(10) Losses per year ($1,000) - These dollar figures are the value of the above KWH losses at 9 mills per KWH.

(11) Present Worth of Losses ($1,000) - These figures are the present worth of losses for 50 years with the first 13 years being of no value.

(12) Total Present Worth of Installation ($1,000) - These figures are the sums of columns 8 and 11.

TABLE 6 EXPLANATIONS

TABLE 6

ECONOMIC ANALYSIS - SUBMARINE CABLE

Voltage (kv)	Armor	Cond. Size (MCM or AWG)	Mat'l Cost $1,000	Labor Cost $1,000	COST Initial $1,000	COST Yearly 30-yr Life $1,000	COST P.W. on 50-yr Life $1,000
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
115	ST	4/0	418	160	578	30	754
115	AL	4/0	531.5	160	691.5	35.8	900
115	AL	450	616.5	160	776.5	40.2	1010
115	ST	1000	647.5	160	807.5	41.8	1050
138	ST	250	458	160	618	32	804
138	AL	250	580.5	160	740.5	38.4	965
138	AL	350	617	160	777	40.2	1010
138	ST	550	558	160	718	37.2	935
161	ST	250	509	160	669	34.7	871
161	AL	250	687	160	847	43.9	1110
161	AL	350	730	160	890	46.1	1158
161	AL	450	761	160	921	47.7	1198

	Losses per Year (MWH)	Losses per Year $1,000	P.W. of Losses $1,000	Total P.W. of Installtn $1,000
	(9)	(10)	(11)	(12)
	2,587	23.3	340	1094
	1,887	17.0	248	1148
	1,355	12.2	178	1188
	1,605	14.4	210	1260
	1,587	14.3	208	1012
	1,324	11.9	173	1138
	1,242	11.2	163	1173
	1,481	13.3	194	1129
	1,360	12.3	179	1050
	1,204	10.8	157	1267
	1,122	10.1	147	1305
	1,098	9.9	144	1342

TABLE 6

2

EXPLANATION OF TABLE 7

SUBMARINE CABLE LOSS TABULATION

Following constants and formulas were used in calculating submarine cable losses. All losses were calculated based on loading assumption A. Losses on loading assumptions B, C and D can be quickly approximated by using the multiplying factors developed in the overhead section analysis:

Resistances (ohms per circular mil foot)

Copper (100 percent IACS) - - - - - - - - - - - -	10.371
Aluminum (61 percent IACS) - - - - - - - - - - - -	17.0
Aluminum Alloy #5052 (est. 35 percent IACS) - - -	29.6
Lead (7.84 percent IACS) - - - - - - - - - - - - -	132.3
Steel (11.04 percent IACS) - - - - - - - - - - - -	93.8

#4 AWG = 41,740 CM., O.D. = 0.204"
#4/0 AWG = 211,600 CM.
#6 BWG = 36,864 CM., O.D. = 0.192"
#4BWG = 53,824 CM., O.D. = 0.232"

Loss formulas, watts per foot and nomenclature from Reference 2

<u>Conductor Loss</u> - W_c

$$W_c = \text{Ave. } I^2 \times 1.09 \times \frac{R_c}{10^6}$$

where R_c = Conductor AC resistance, ohms/cm.ft.
and I = current in amperes

<u>Insulation Loss</u> - W_d

$$W_d = \frac{0.00276\ E^2\ r\text{Cos}}{\log_{10} \frac{2T + D_c}{D_c}}$$

where E	=	voltage, line to ground, kv
r	=	insulation specific capacitance = 3.5
Cos	=	insulation P.F., = 0.006
T	=	insulation thickness, inches
D_c	=	conductor O.D., inches

<u>Sheath and Armor Loss</u> W_{sa}

$$W_{sa} \quad I^2_{ave} \times 1.09 \times R_{sa}$$

where R_{sa} is sheath and armor parallel resistance, ohms/cm.ft.
losses divide inversely proportional to resistance.
Armor A.C. resistance assumed 50 percent more than R_{dc} including 4 percent cable lay addition.

TABLE 7

SUBMARINE CABLE LOSS TABULATION

		CONDUCTOR				INSULATION			SHEATH					
Volts (kv)	Avg. Curr (amps)	Size (MCM)	O.D. (in.)	Res. μΩ/ft.	Losses W_c (w/ft)	TH. (in.)	O.D. (in.)	Losses W_d (w/ft)	TH. (in.)	I.D. (in.)	O.D. (in.)	Area (MCM)	Res. μΩ/ft	Lo W (w
115	206	4/0	.800	49.0	2.54	.435	1.67	.86	.120	1.68	1.92	870	153.2	1.
115	206	4/0	.800	49.0	2.54	.435	1.67	.86	.120	1.68	1.92	870	153.2	.
115	206	450	.98	23.5	1.09	.435	1.85	1.00	.125	1.86	2.11	1000	132.3	.
115	206	1000	1.303	10.4	.43	.435	2.18	1.24	.130	2.19	2.45	1200	111.1	.
138	168	250	.833	42.3	1.30	.505	1.843	1.07	.125	1.85	2.10	1000	132.3	.
138	168	250	.833	42.3	1.30	.505	1.843	1.07	.125	1.85	2.10	1000	132.3	.
138	168	350	.906	30.3	.935	.505	1.916	1.22	.125	1.92	2.17	1020	130.0	.
138	168	550	1.048	18.9	.581	.505	2.058	1.25	.130	2.07	2.33	1140	116.0	.
161	143	250	.833	42.3	.945	.590	2.013	1.31	.125	2.02	2.27	1000	121.0	.
161	143	250	.833	42.3	.945	.590	2.013	1.31	.125	2.02	2.27	1000	121.0	.
161	143	350	.906	30.3	.676	.590	2.086	1.38	.130	2.09	2.33	1150	115.0	.
161	143	450	.98	23.5	.524	.590	2.160	1.46	.130	2.17	2.43	1190	111.0	.

	ARMOR						TOTAL
t)	Mat	Size BWG or AWG	No. of Wires	Total Area (MCM)	Res. $\mu\Omega$/ft	Loss W_a (w/ft)	Loss (w/ft)
	ST	6	30	1107	127	1.76	6.620
68	AL	4	30	1250	35.5	1.077	4.735
13	AL	4	33	1466	30.4	.932	3.233
00	ST	4	33	1777	79.0	1.23	3.860
71	ST	4	33	1770	79.3	.955	3.896
57	AL	4	33	1380	32.2	.645	3.172
58	AL	4	36	1304	29.6	.605	2.896
71	ST	6	36	1330	106	.932	3.534
54	ST	4	38	2040	68.7	.623	3.232
95	AL	4	38	1590	27.9	.412	2.762
00	AL	4	40	1676	26.3	.389	2.535
55	AL	4	42	1755	25.3	.374	2.443

TABLE 7

FIGURES

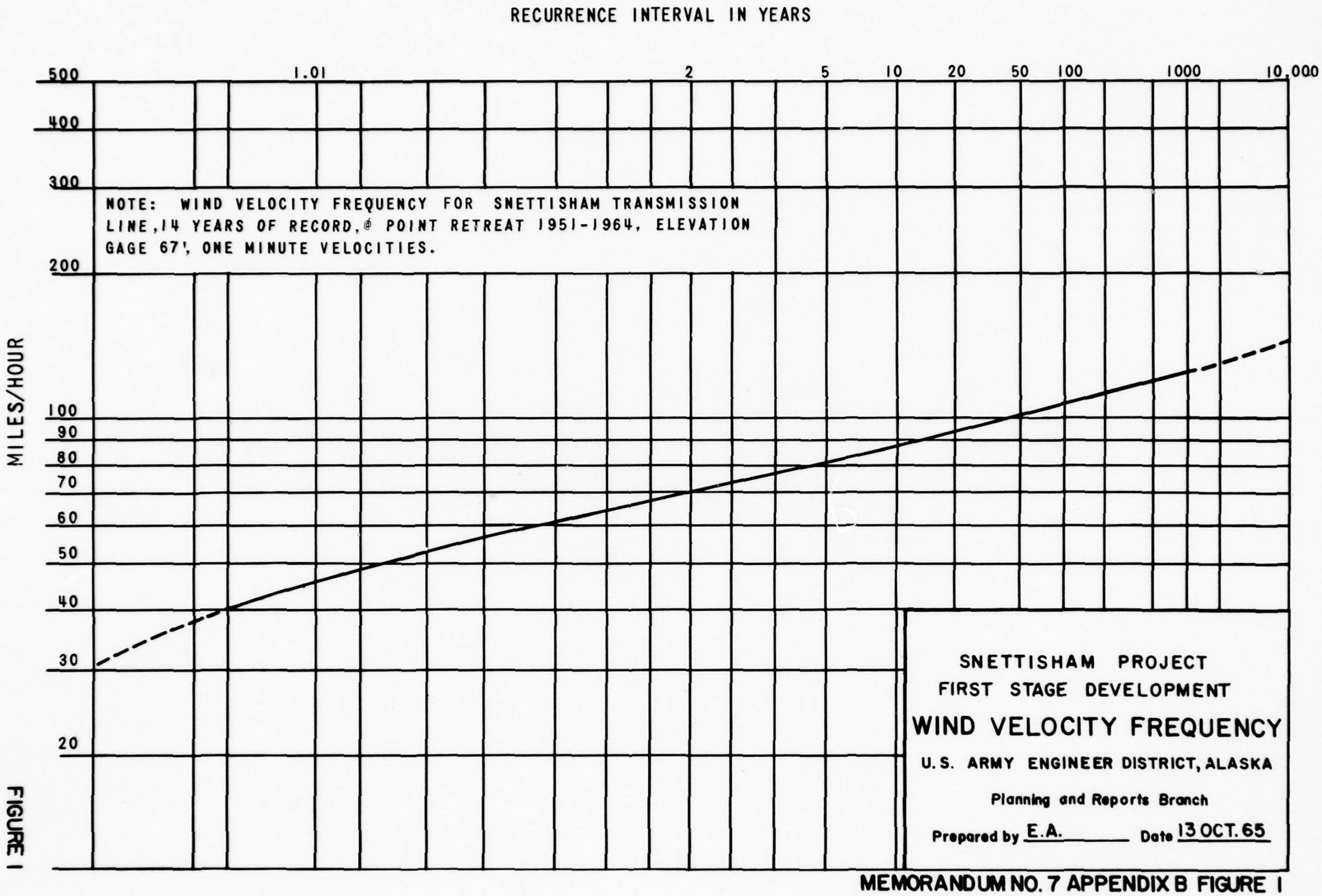
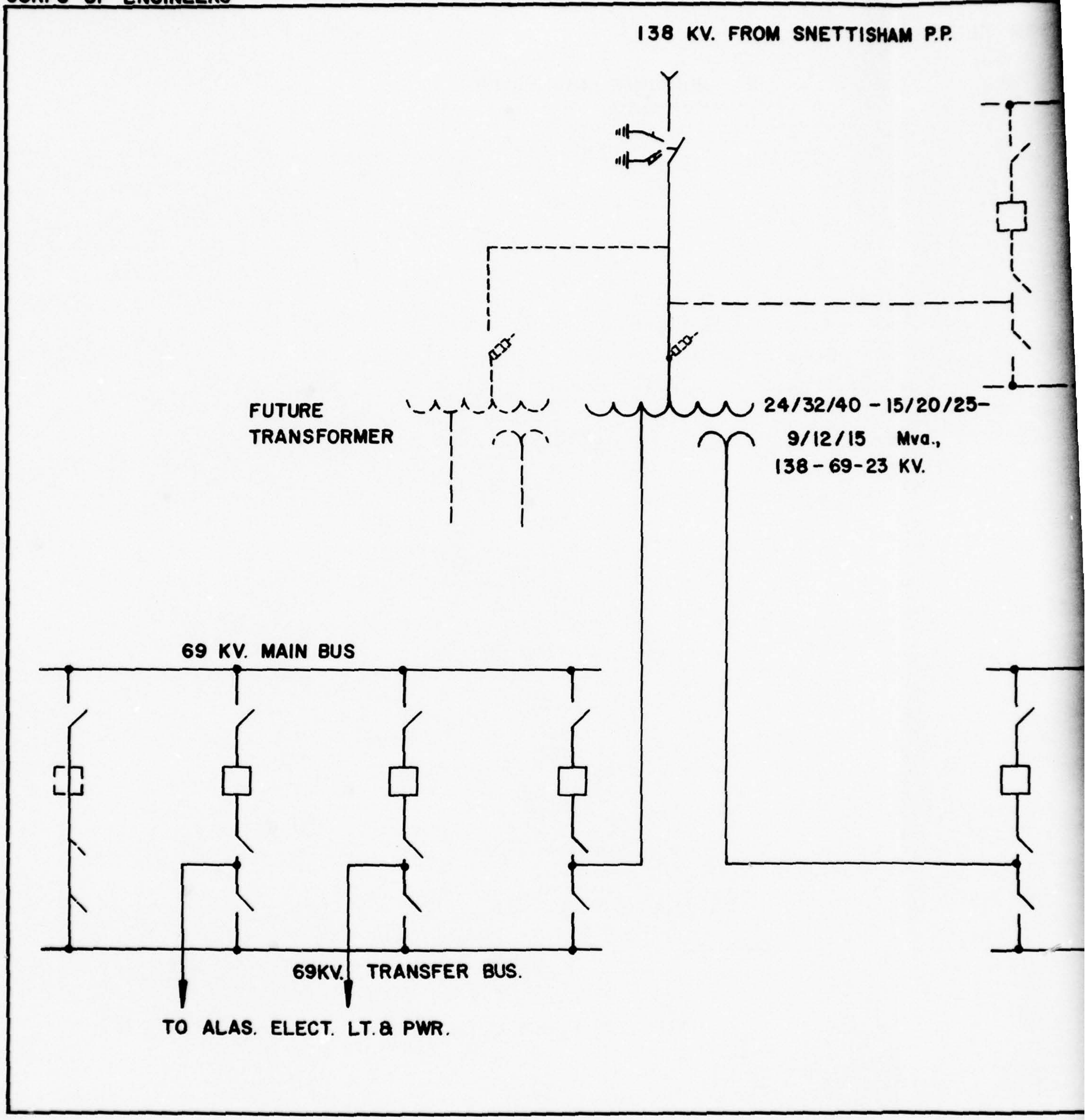
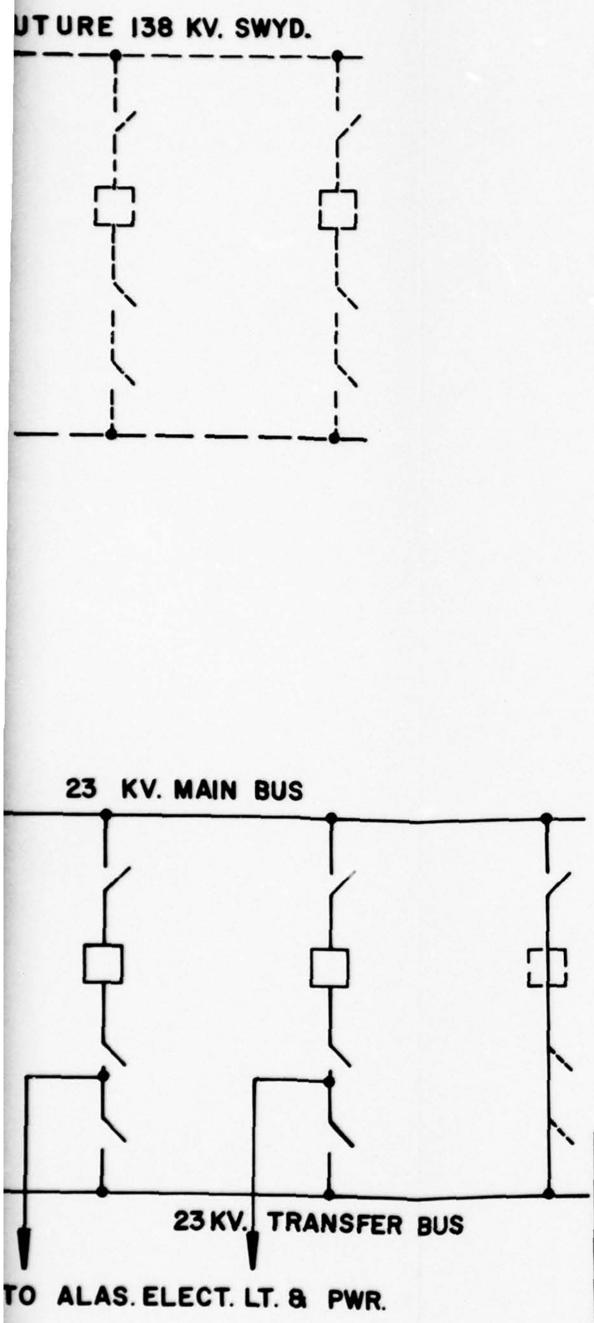

RECURRENCE INTERVAL IN YEARS
1.01
2
5
10
20
50
100
1000
10,000
MILES/HOUR
500
400
300
200
100
90
80
70
60
50
40
30
20
NOTE: WIND VELOCITY FREQUENCY FOR SNETTISHAM TRANSMISSION LINE, 14 YEARS OF RECORD, @ POINT RETREAT 1951-1964, ELEVATION GAGE 67', ONE MINUTE VELOCITIES.
SNETTISHAM PROJECT
FIRST STAGE DEVELOPMENT
WIND VELOCITY FREQUENCY
U.S. ARMY ENGINEER DISTRICT, ALASKA
Planning and Reports Branch
Prepared by E.A. Date 13 OCT. 65
MEMORANDUM NO. 7 APPENDIX B FIGURE I

FIGURE I


138 KV. FROM SNETTISHAM P.P.
FUTURE TRANSFORMER
24/32/40 - 15/20/25-
9/12/15 Mva.,
138 - 69 - 23 KV.
69 KV. MAIN BUS
69KV. TRANSFER BUS.
TO ALAS. ELECT. LT. & PWR.

U.S. ARMY



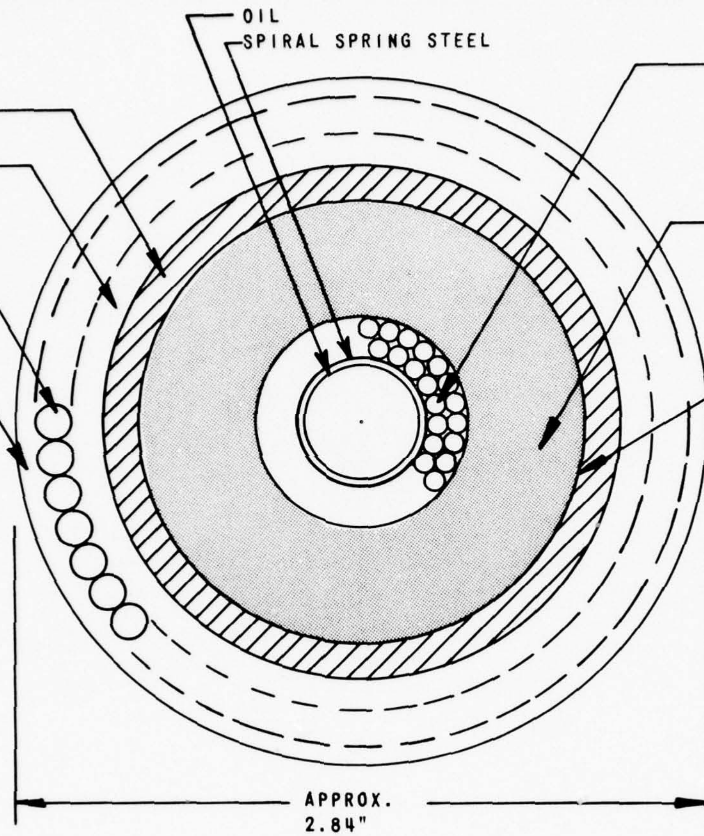
SNETTISHAM PROJECT
FIRST STAGE DEVELOPMENT

JUNEAU SUBSTATION
SWITCHING DIAGRAM

U.S. ARMY ENGINEER DISTRICT, ALASKA
Planning and Reports Branch
Prepared by T.L. Date 7 OCT 65

DESIGN MEMORANDUM NO. 7 APPENDIX B FIGURE 2

CORPS OF ENGINEERS | U.S. ARMY



NOTE:

SINGLE CONDUCTOR 250,000 CM 0.60" O.D. HOLLOW CORE LOW-PRESSURE OIL-FILLED 138KV SUBMARINE CABLE.

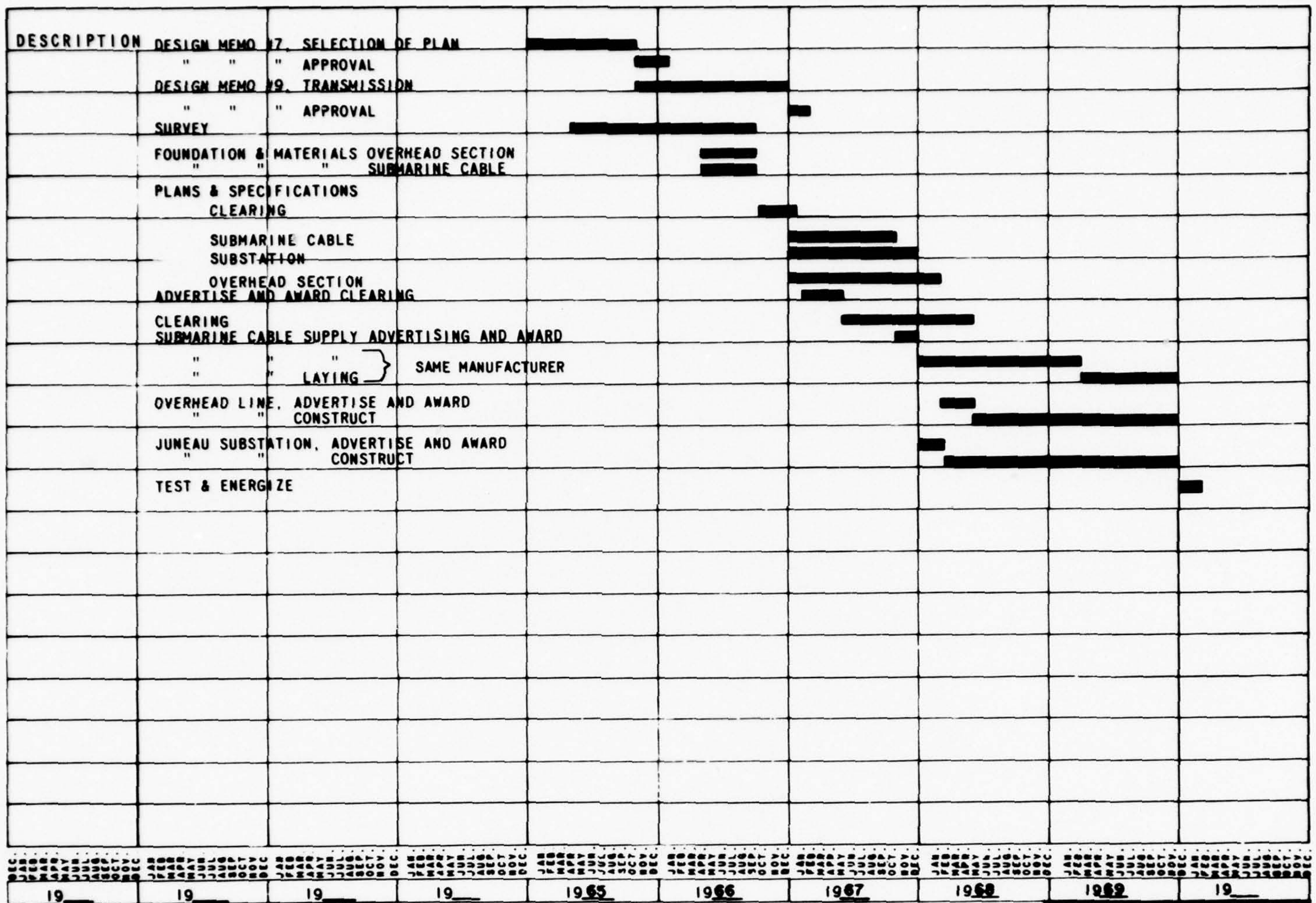
SNETTISHAM PROJECT
FIRST STAGE DEVELOPMENT

OIL FILLED SUBMARINE CABLE

U.S. ARMY ENGINEER DISTRICT, ALASKA
Planning and Reports Branch
Prepared by E.A. Date 13 OCT 65

DESIGN MEMORANDUM NO. 7 APPENDIX B FIGURE 3

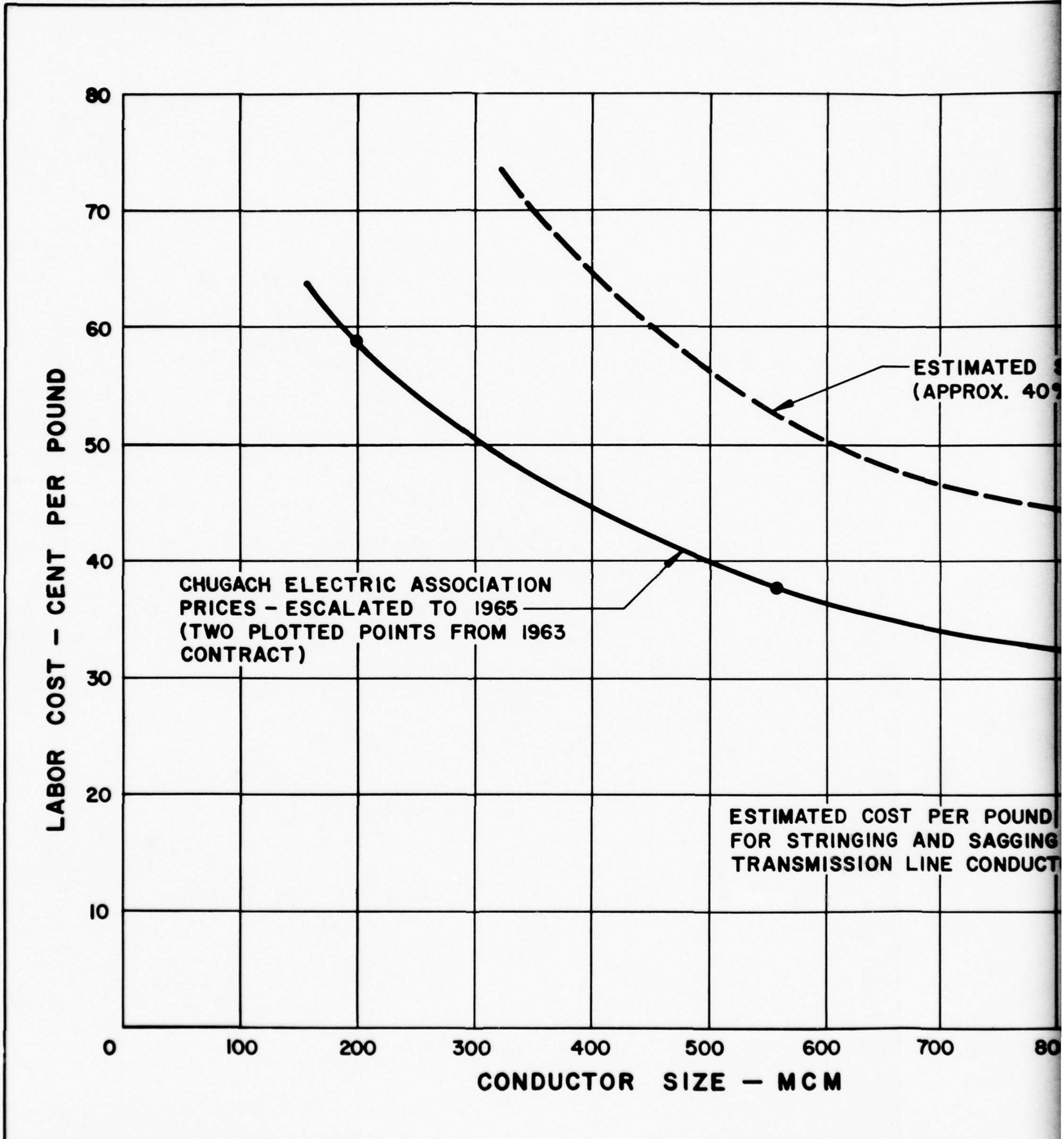
FIGURE 3



SNETTISHAM PROJECT
FIRST STAGE DEVELOPMENT
SCHEDULE FOR DESIGN
& CONSTRUCTION
U.S. ARMY ENGINEER DISTRICT, ALASKA
Planning and Reports Branch
Prepared by E.A. Date 11 OCT 65

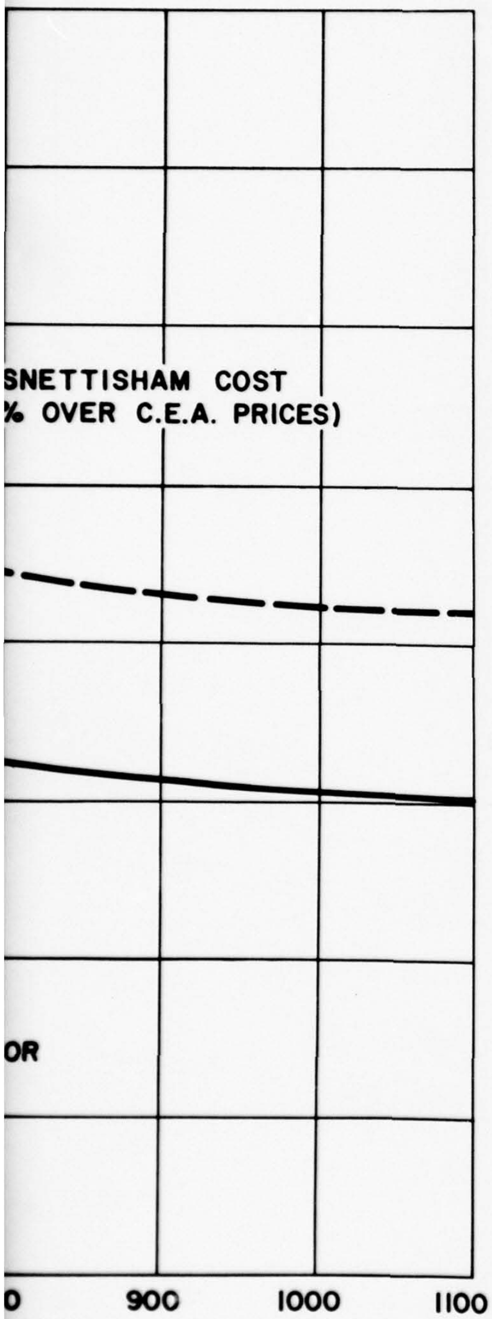
DESIGN MEMORANDUM NO.7 APPENDIX B FIGURE 4

FIGURE 4



80
70
60
50
40
30
20
10
0
100
200
300
400
500
600
700
80
LABOR COST - CENT PER POUND
CONDUCTOR SIZE — MCM
ESTIMATED
(APPROX. 40
CHUGACH ELECTRIC ASSOCIATION
PRICES - ESCALATED TO 1965
(TWO PLOTTED POINTS FROM 1963
CONTRACT)
ESTIMATED COST PER POUND
FOR STRINGING AND SAGGING
TRANSMISSION LINE CONDUCT

U.S. ARMY



SNETTISHAM PROJECT
FIRST STAGE DEVELOPMENT

CONDUCTOR LABOR COST ESTIMATE

U.S. ARMY ENGINEER DISTRICT, ALASKA

Planning and Reports Branch

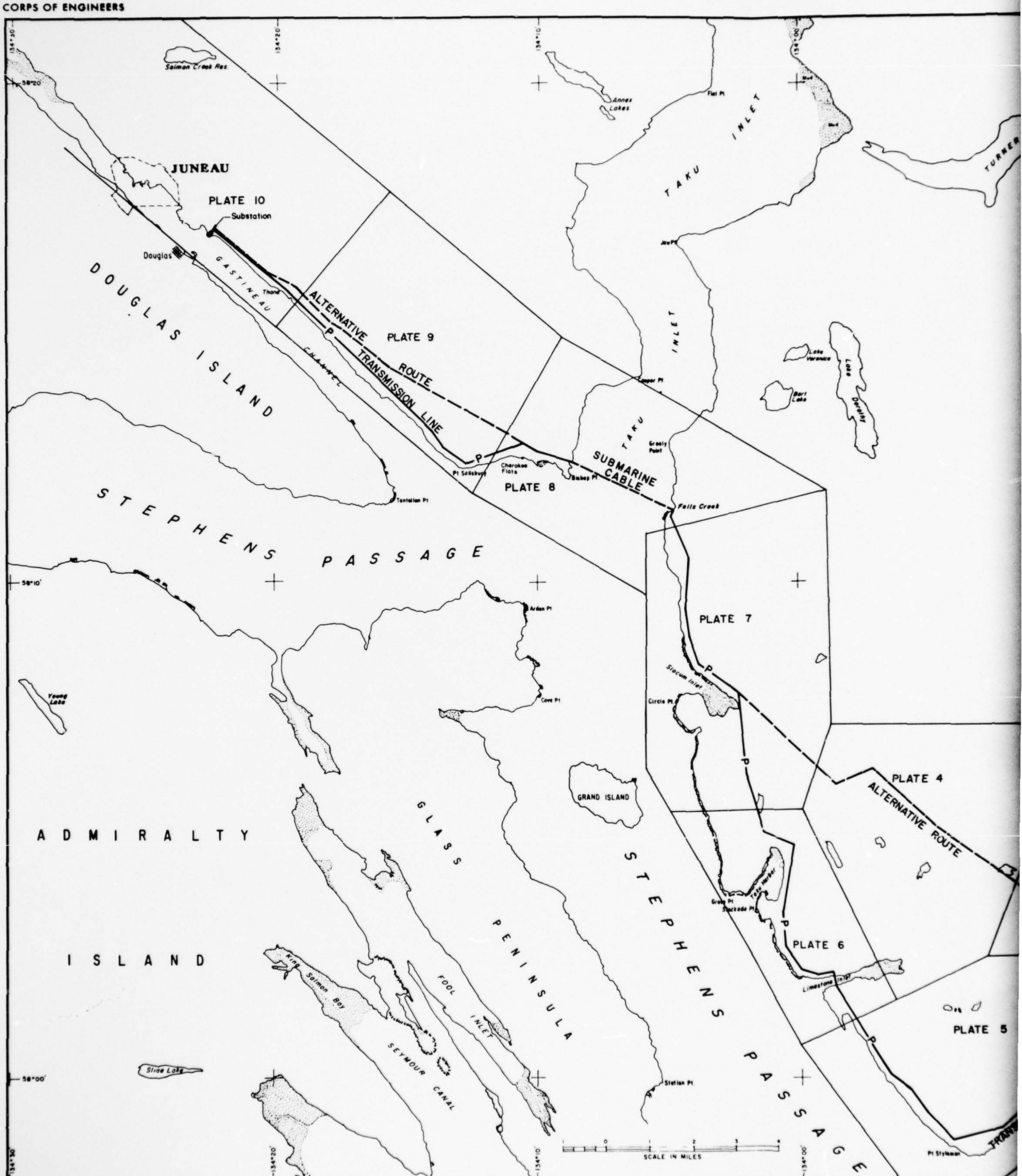
Prepared by T.L. Date 11 OCT 65

MEMORANDUM NO. 7 APPENDIX B FIGURE 5

2

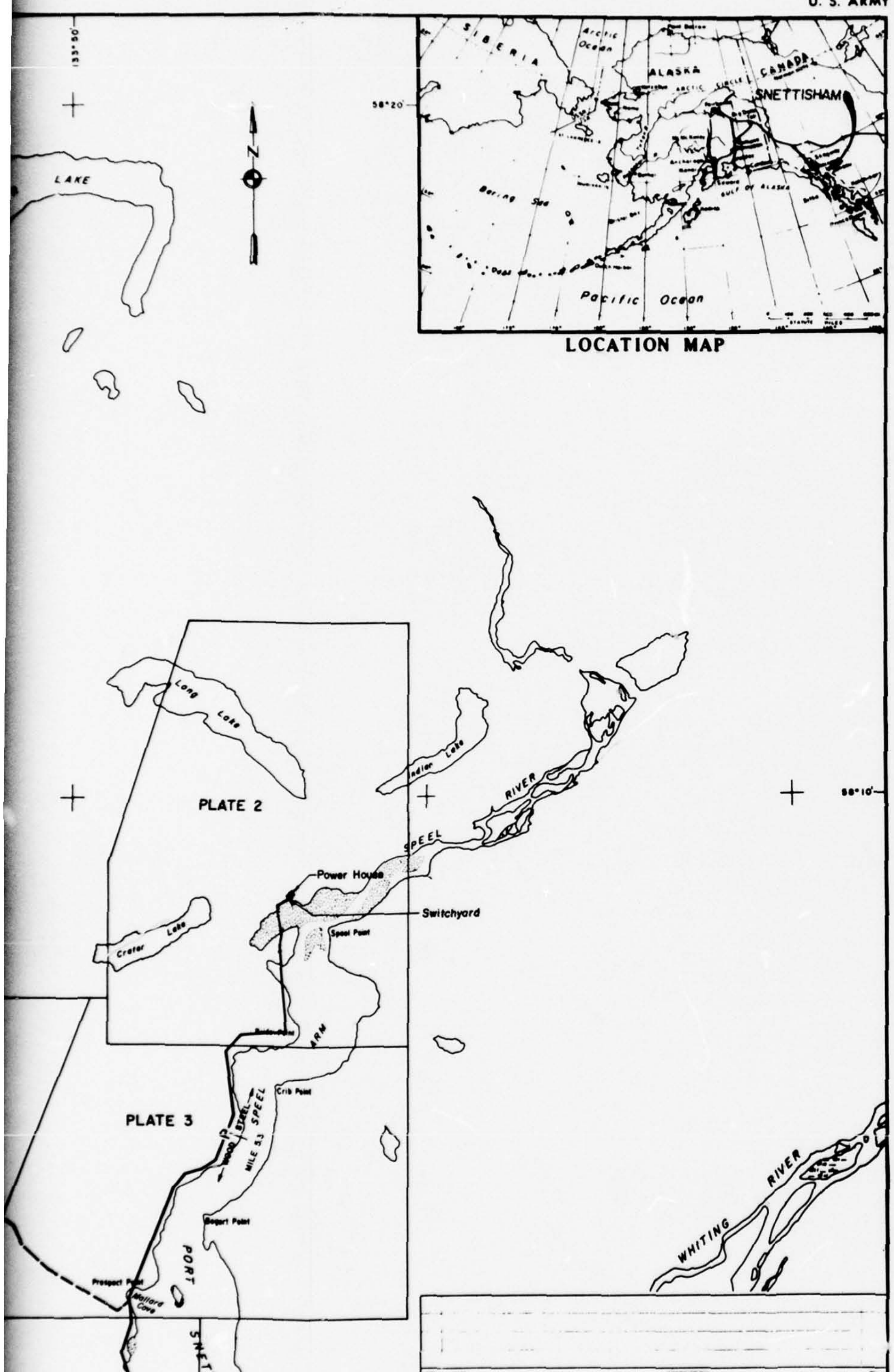
PLATES

CORPS OF ENGINEERS



1

U. S. ARMY



REV	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT. ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

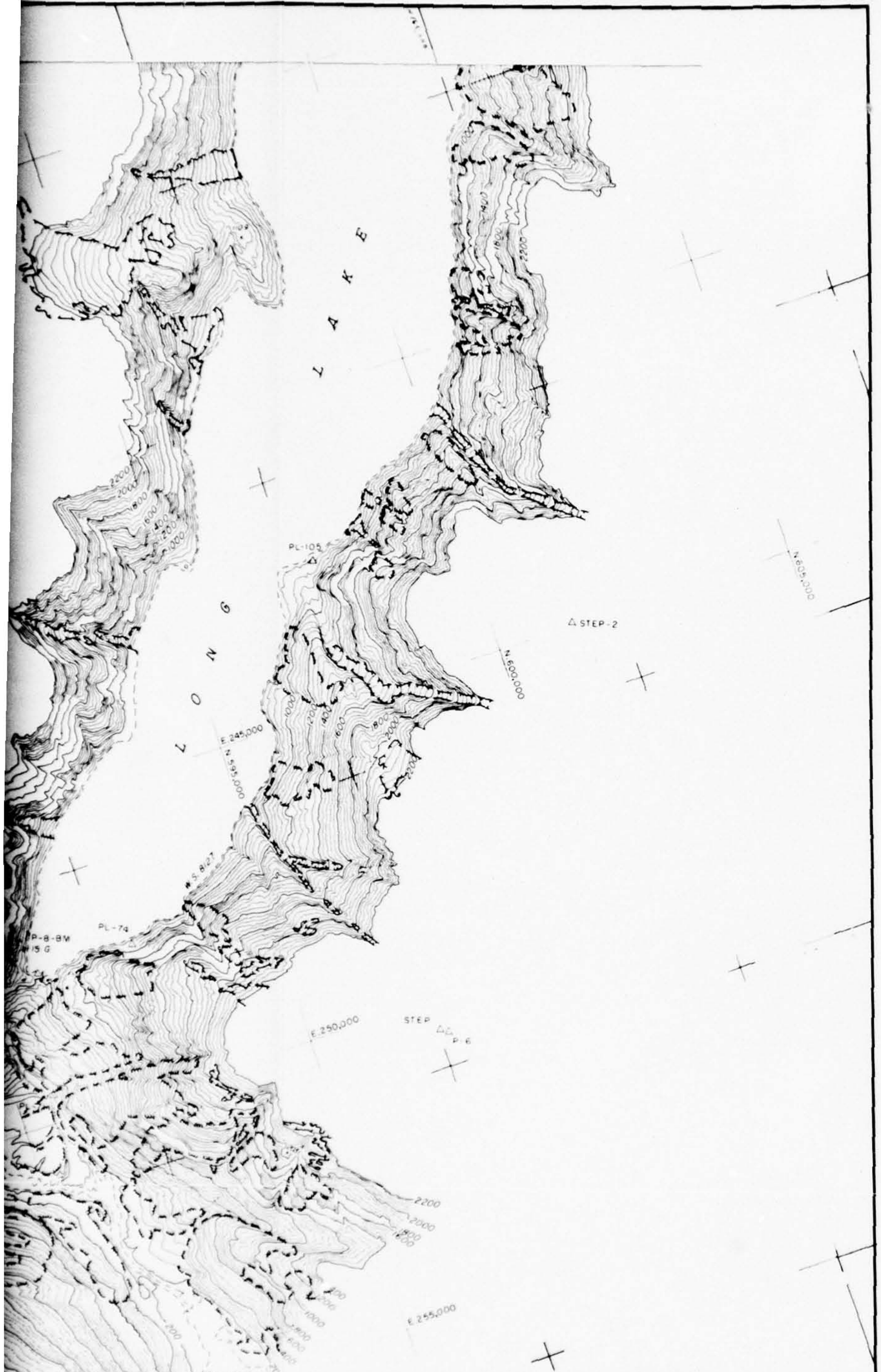
DESIGNED: E.A.	SNETTISHAM PROJECT, ALASKA
DRAWN: K.H.	FIRST STAGE DEVELOPMENT
CHECKED: H.S.	**TRANSMISSION KEY MAP**
PREPARED: E.A.	

SUPERVISED: Fenzes Straub P.E. CHIEF, ADVANCED PLANNING SECTION	APPROVED: Clair J. Farley COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: CHIEF, PLANNING & REPORTS BRANCH	SCALE AS SHOWN / DATE 22 OCT 1966
RECOMMENDED: Warren George CHIEF, ENGINEERING DIVISION	FILE NUMBER Q-4-5-113 / SHEET 1 OF 12

DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE I


CRATER LAKE
SPEEL ARM
Star Point
Switchyard
UPPER PEAR L
LOWER PEAR LAKE
SPIRE
Grid North
E 235,000
E 240,000
Match Line Sheet 3
SCALE IN FEET
1000 0 1000 2000
LEGEND
Woodland
Snow or Ice

U. S. ARMY



U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: E.A. & T.L.	SNETTISHAM PROJECT, ALASKA
DRAWN: T.L.S.	FIRST STAGE DEVELOPMENT
CHECKED: H.S.	TRANSMISSION LINE LOCATION
PREPARED: E.A.	

SUPERVISED: Henry Straub P.E.	APPROVED: Clare J. Farley	
SUBMITTED:	SCALE AS SHOWN	DATE 22 OCT 1965
RECOMMENDED: Warren Gross	SHEET 2 OF	FILE NUMBER Q-4-5-113

DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE 2

CORPS OF ENGINEERS

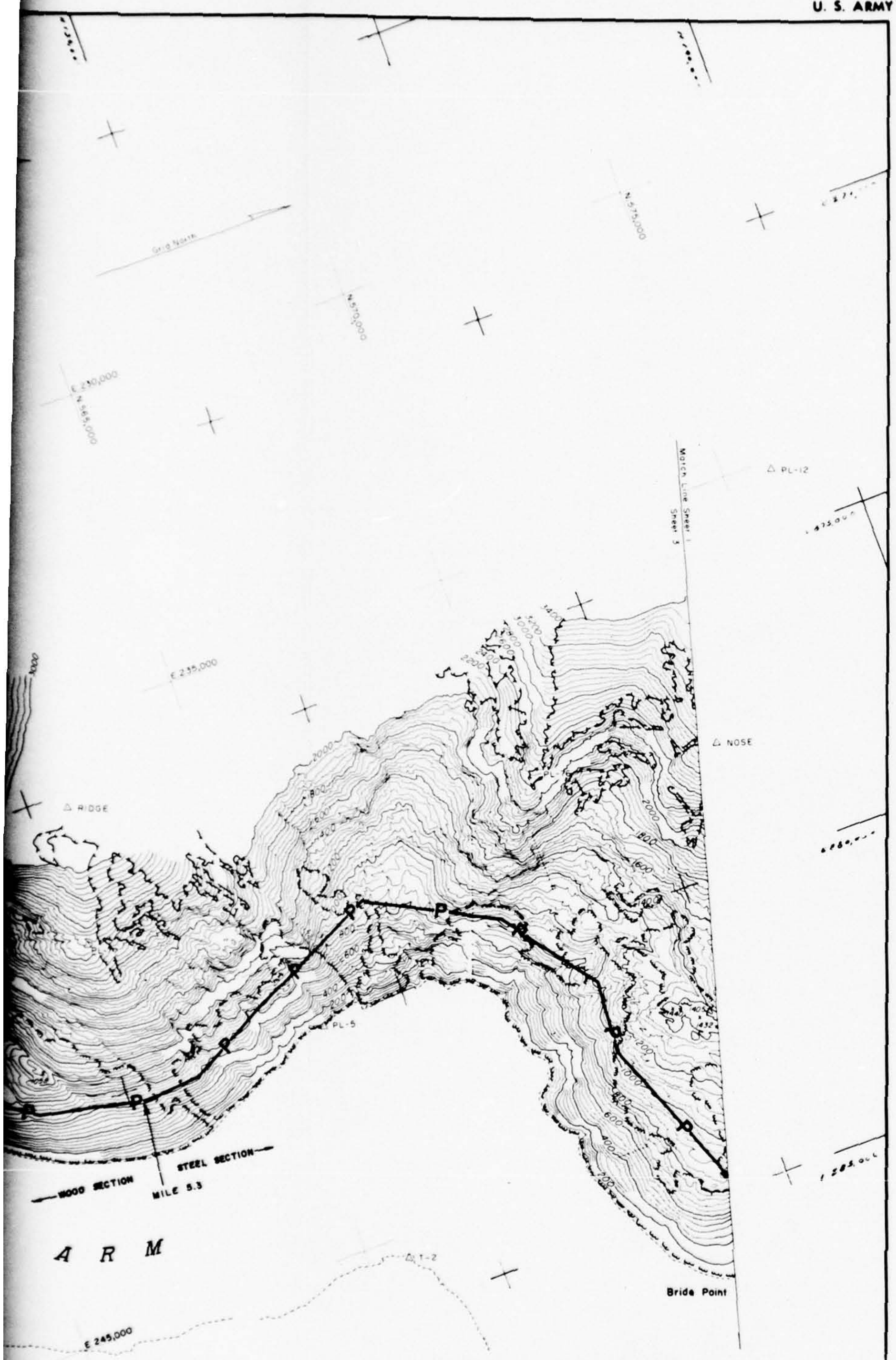
SCALE IN FEET

1000 0 1000 2000

LEGEND

Woodland

Snow or Ice



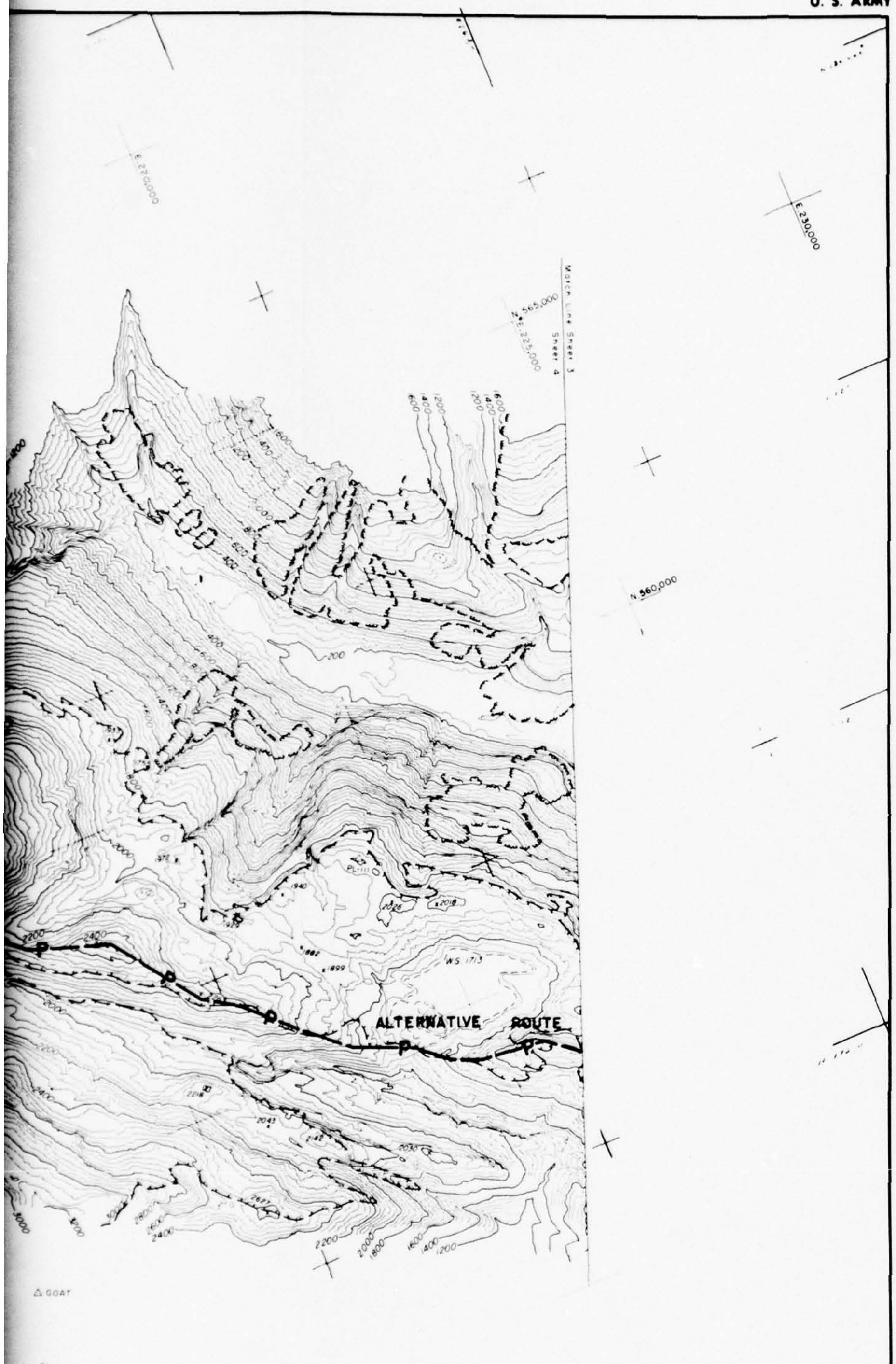
U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: E.A. & T.L.	SNETTISHAM PROJECT, ALASKA
DRAWN: K.H.	FIRST STAGE DEVELOPMENT
CHECKED: H.S.	**TRANSMISSION LINE LOCATION**
PREPARED: E.A.	

SUPERVISED: Henri Straub P.E.	APPROVED: [signature]
SUBMITTED: [signature]	SCALE AS SHOWN — DATE 22 OCT 1968
RECOMMENDED: Warren George	FILE NUMBER Q-4-5-113 — SHEET 3 OF


ALTERNATIVE ROUTE
ALTERNATIVE ROUTE
Grid North
Match Line Sheet 7
Sheet 4
Match Line Sheet 6
Sheet 4
N.575,000
N.570,000
N.555,000
E.195,000
E.200,000
E.205,000
E.210,000
E.215,000
PL-114
PL-113
SCALE IN FEET
1000
0
1000
2000
LEGEND
Woodland
Snow or Ice

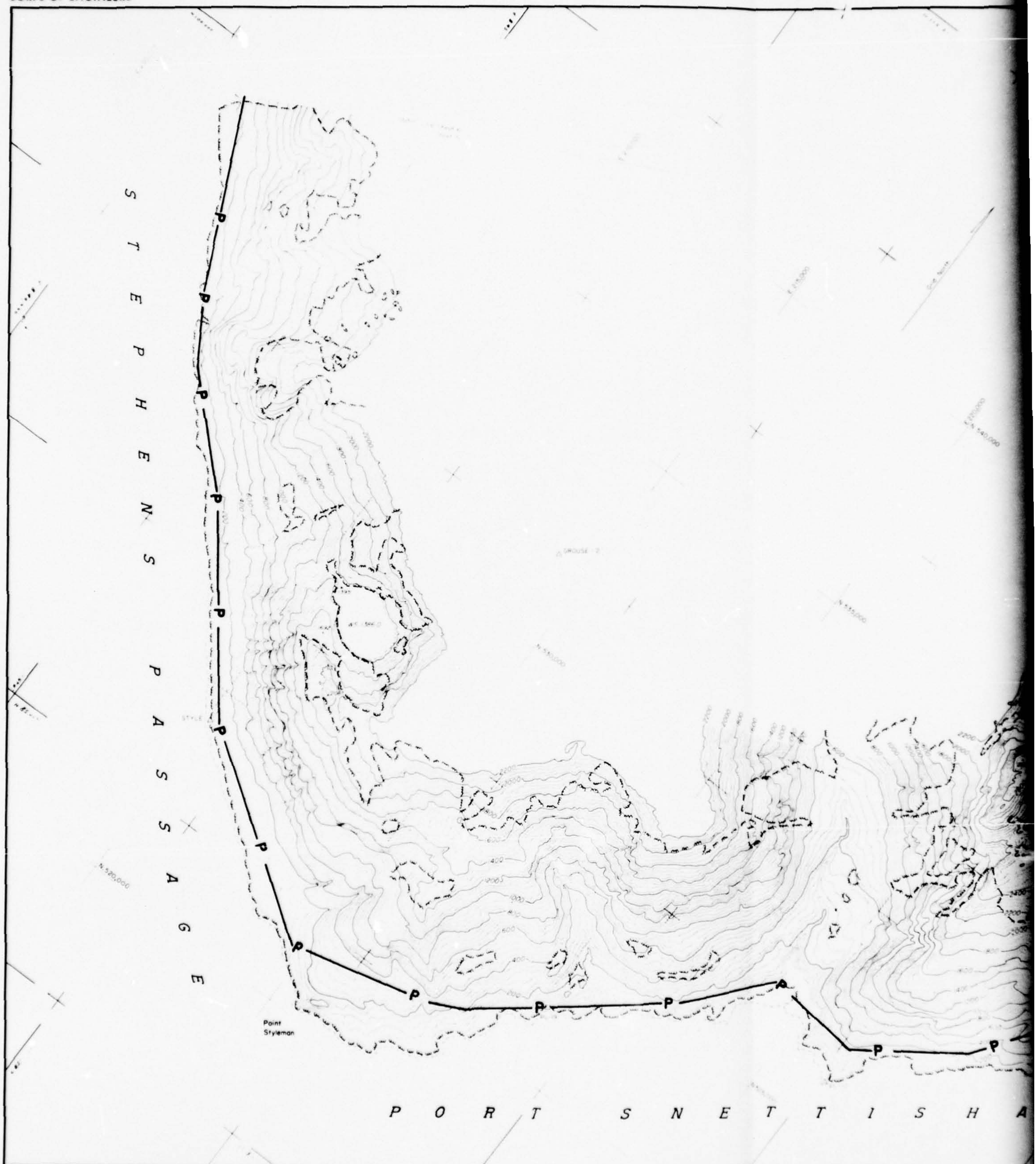
U. S. ARMY



U.S. ARMY ENGINEER DISTRICT, ALASKA CORPS OF ENGINEERS ANCHORAGE, ALASKA	
DESIGNED: E.A. & T.L. DRAWN: T.L.S. CHECKED: H.S. PREPARED: E.A.	SNETTISHAM PROJECT, ALASKA FIRST STAGE DEVELOPMENT TRANSMISSION LINE LOCATION
SUPERVISED: Henry Strout P.E.	APPROVED: Clair F. Farley
SUBMITTED: George F. Hyrd	SCALE AS SHOWN — DATE 22 OCT 1965
RECOMMENDED: Borsen George	SHEET 4 OF — FILE NUMBER Q-4-5-113

DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE 4

CORPS OF ENGINEERS



SCALE IN FEET

1000 0 1000 2000

LEGEND

Woodland

Snow or Ice

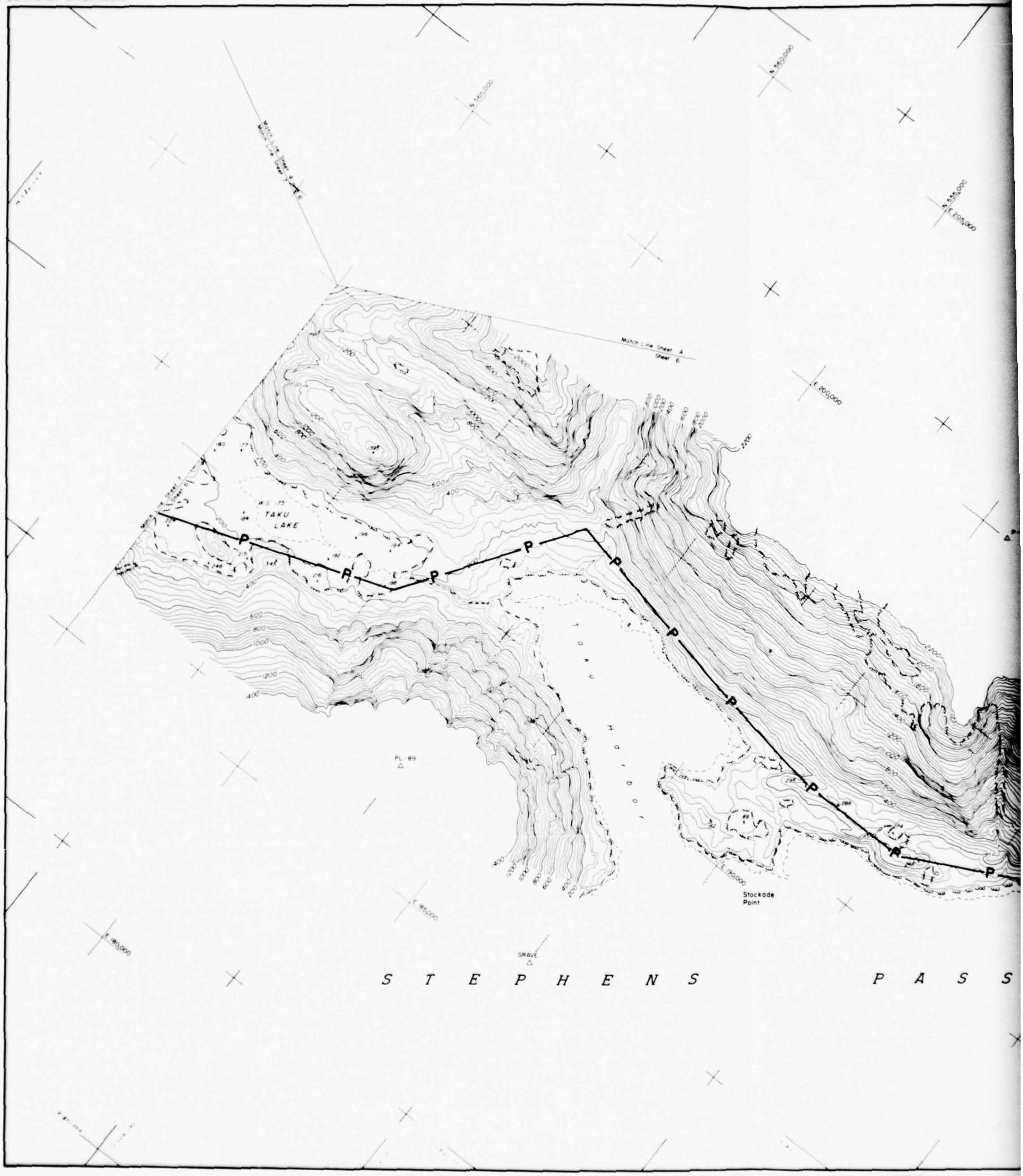
U. S. ARMY

U.S. ARMY ENGINEER DISTRICT. ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: EA & TL	SNETTISHAM PROJECT, ALASKA
DRAWN: KH	FIRST STAGE DEVELOPMENT
CHECKED: HS	**TRANSMISSION LINE LOCATION**
PREPARED: EA	
SUPERVISED: Henry Straub P.E. — CHIEF, ADVANCED PLANNING SECTION	APPROVED: — COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: — CHIEF, PLANNING & REPORTS BRANCH	SCALE AS SHOWN — DATE 22 OCT 1965
RECOMMENDED: Warren George	SHEET 5 OF — FILE NUMBER Q-4-5-113

DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE 5

CORPS OF ENGINEERS



SCALE IN FEET

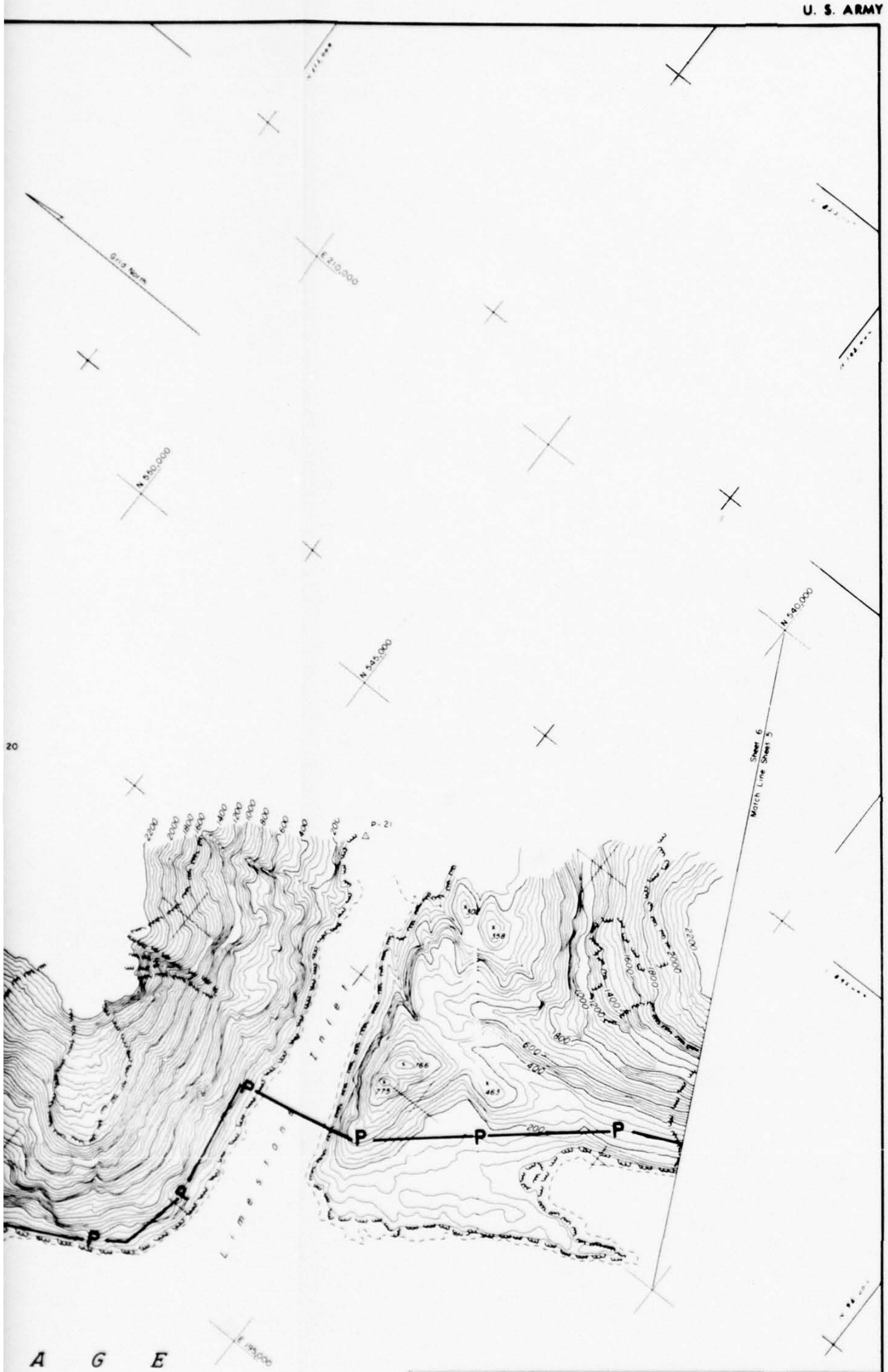
1000 0 1000 2000

LEGEND

Woodland

Snow or Ice

U. S. ARMY



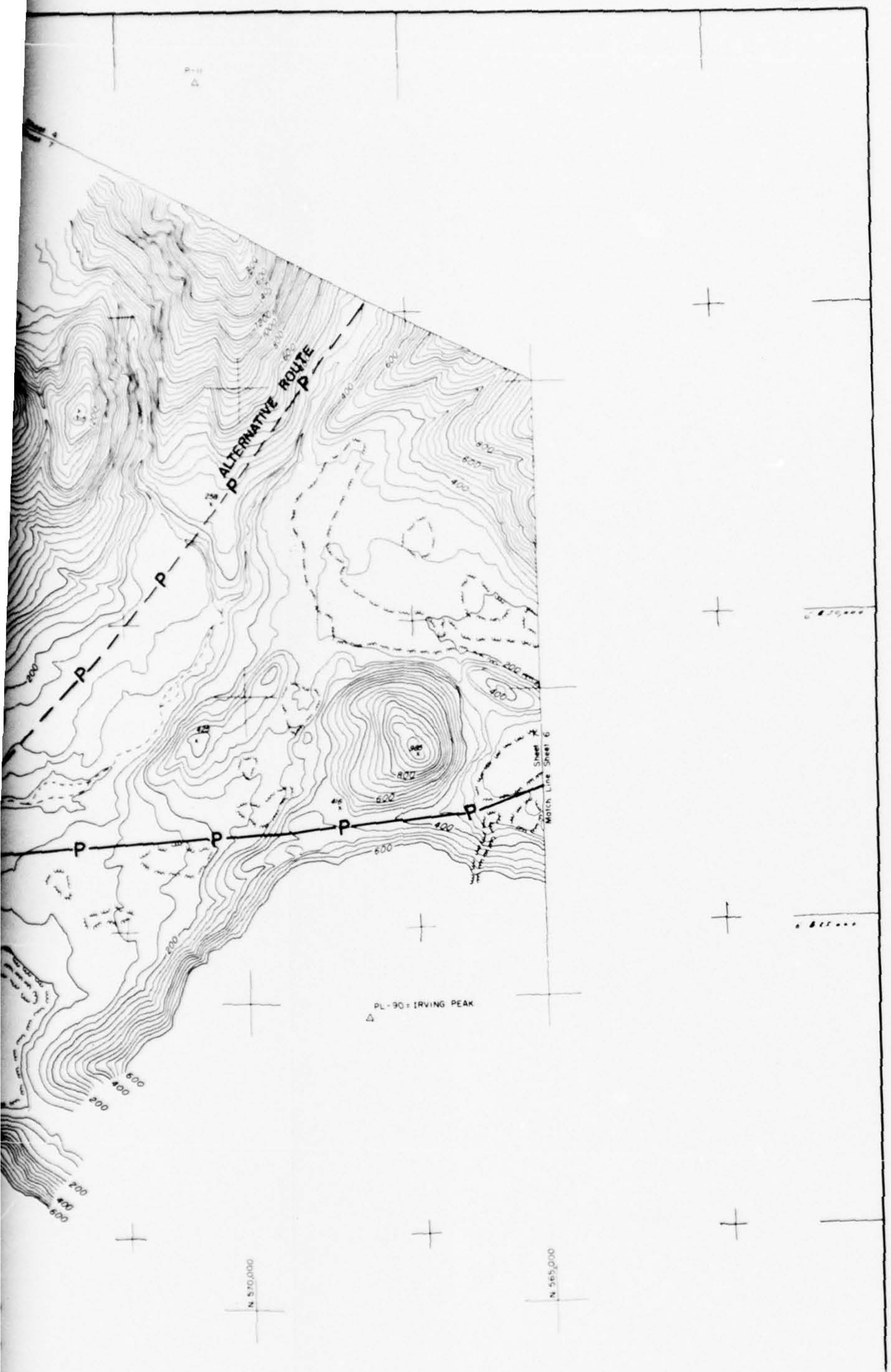
U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: EA & TL	SNETTISHAM PROJECT, ALASKA
DRAWN: TLS	FIRST STAGE DEVELOPMENT
CHECKED: HS	
PREPARED: EA	**TRANSMISSION LINE LOCATION**
SUPERVISED: Henry Straub P.E.	APPROVED:
SUBMITTED:	SCALE: AS SHOWN — DATE 22 OCT., 1965
RECOMMENDED:	SHEET 6 OF — FILE NUMBER Q-4-5-113

DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE 6

CORPS OF ENGINEERS

U. S. ARMY



G E

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: EA & TL	SNETTISHAM PROJECT, ALASKA
DRAWN: KH	FIRST STAGE DEVELOPMENT
CHECKED: HS	
PREPARED: EA	**TRANSMISSION LINE LOCATION**
SUPERVISED: [signature]	APPROVED: [signature]
SUBMITTED: [signature]	SCALE AS SHOWN — DATE 22 OCT., 1965
RECOMMENDED: [signature]	SHEET 7 OF — FILE NUMBER Q-4-5-113

DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE 7

2

CORPS OF ENGINEERS

SCALE IN FEET

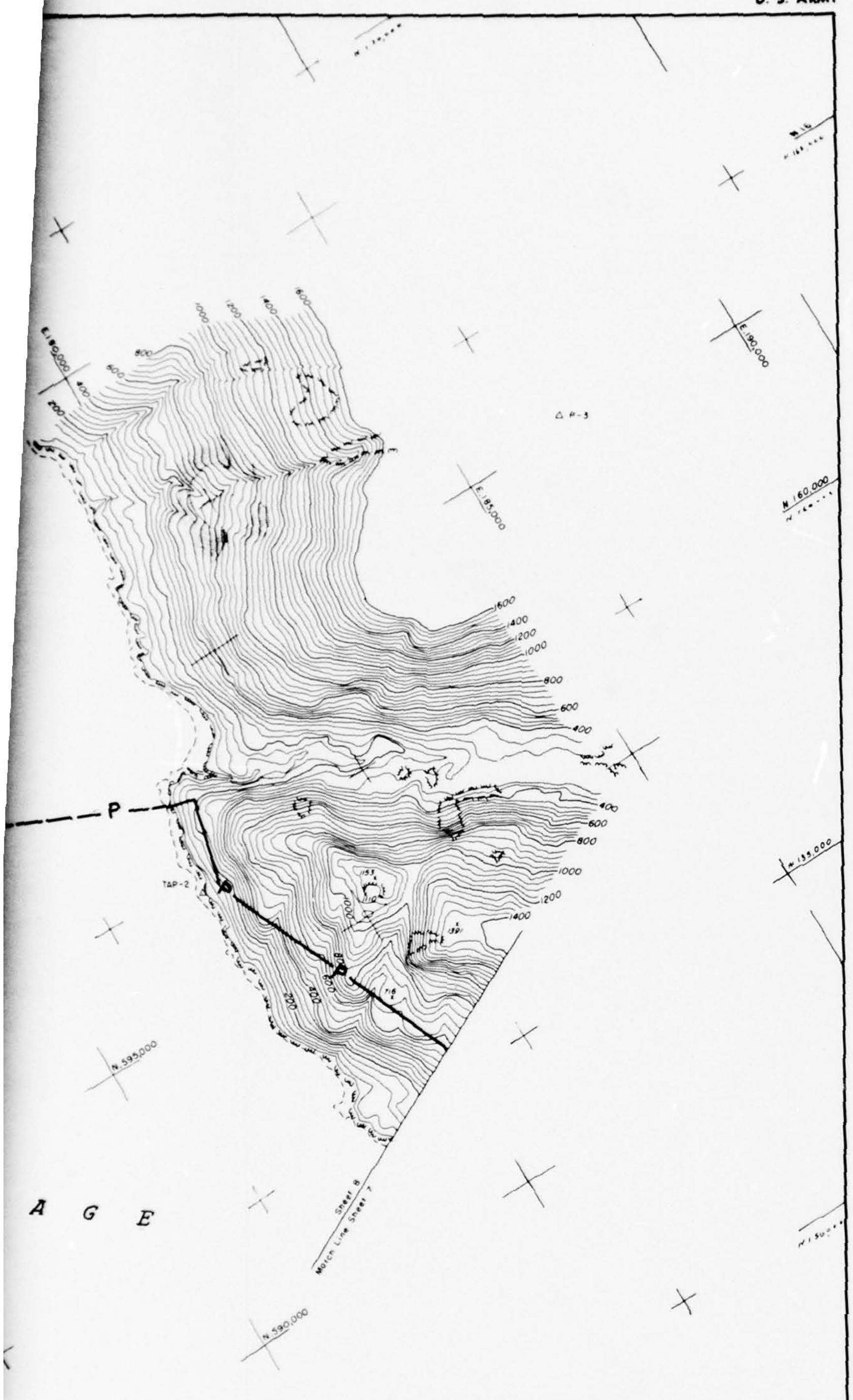
1000 0 1000 2000

LEGEND

Woodland

Snow or Ice

U. S. ARMY



U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA

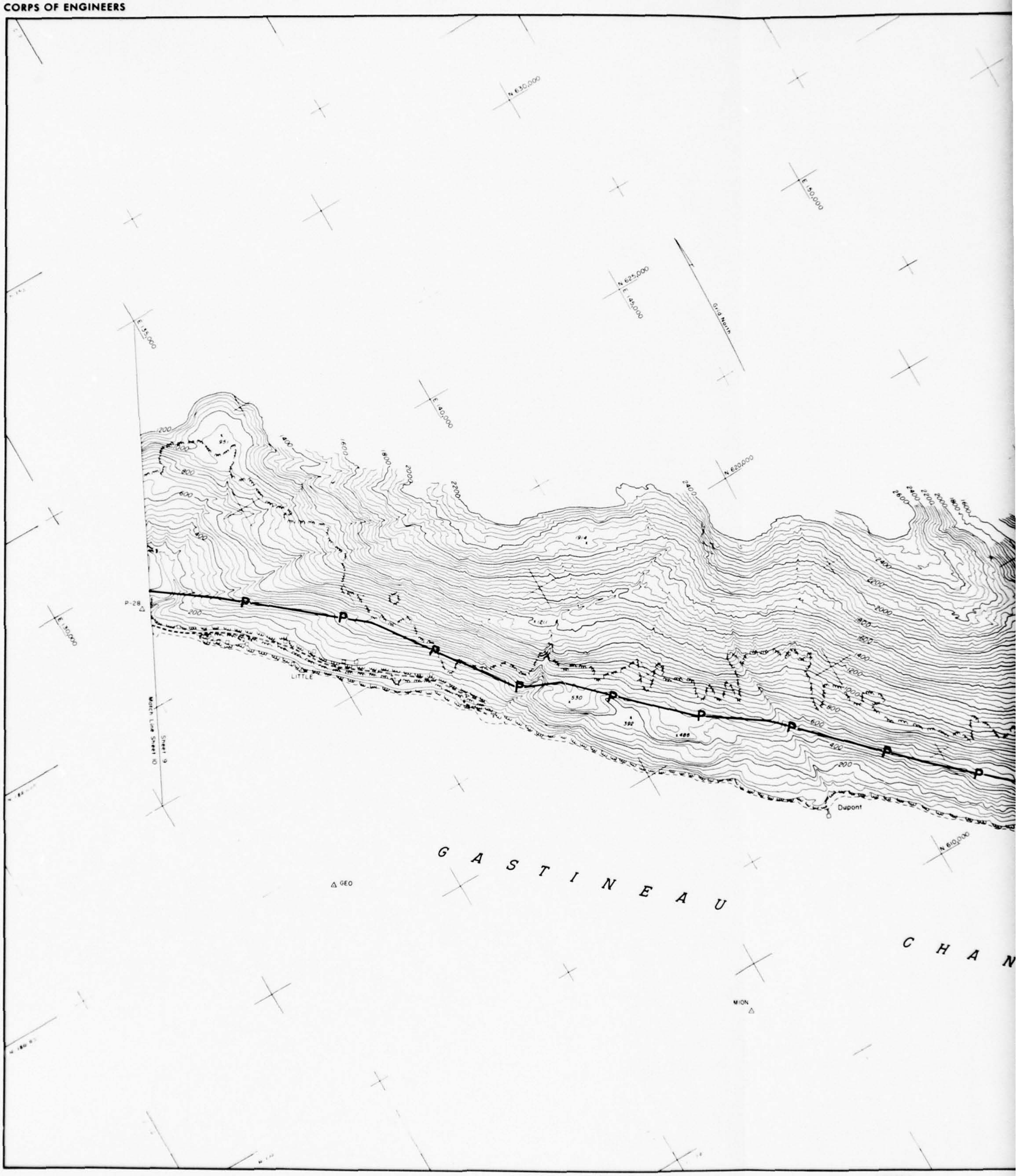
FIRST STAGE DEVELOPMENT

TRANSMISSION LINE LOCATION

DESIGNED: EA & TL	
DRAWN: TLS	
CHECKED: HS	
PREPARED: EA	
SUPERVISED: Henry Straub P.E.	APPROVED: Clar J. Darley
SUBMITTED: [illegible]	SCALE AS SHOWN — DATE 22 OCT., 1965
RECOMMENDED: Warren George	FILE NUMBER Q-4-5-113 — SHEET 8 OF

DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE 8

CORPS OF ENGINEERS



SCALE IN FEET

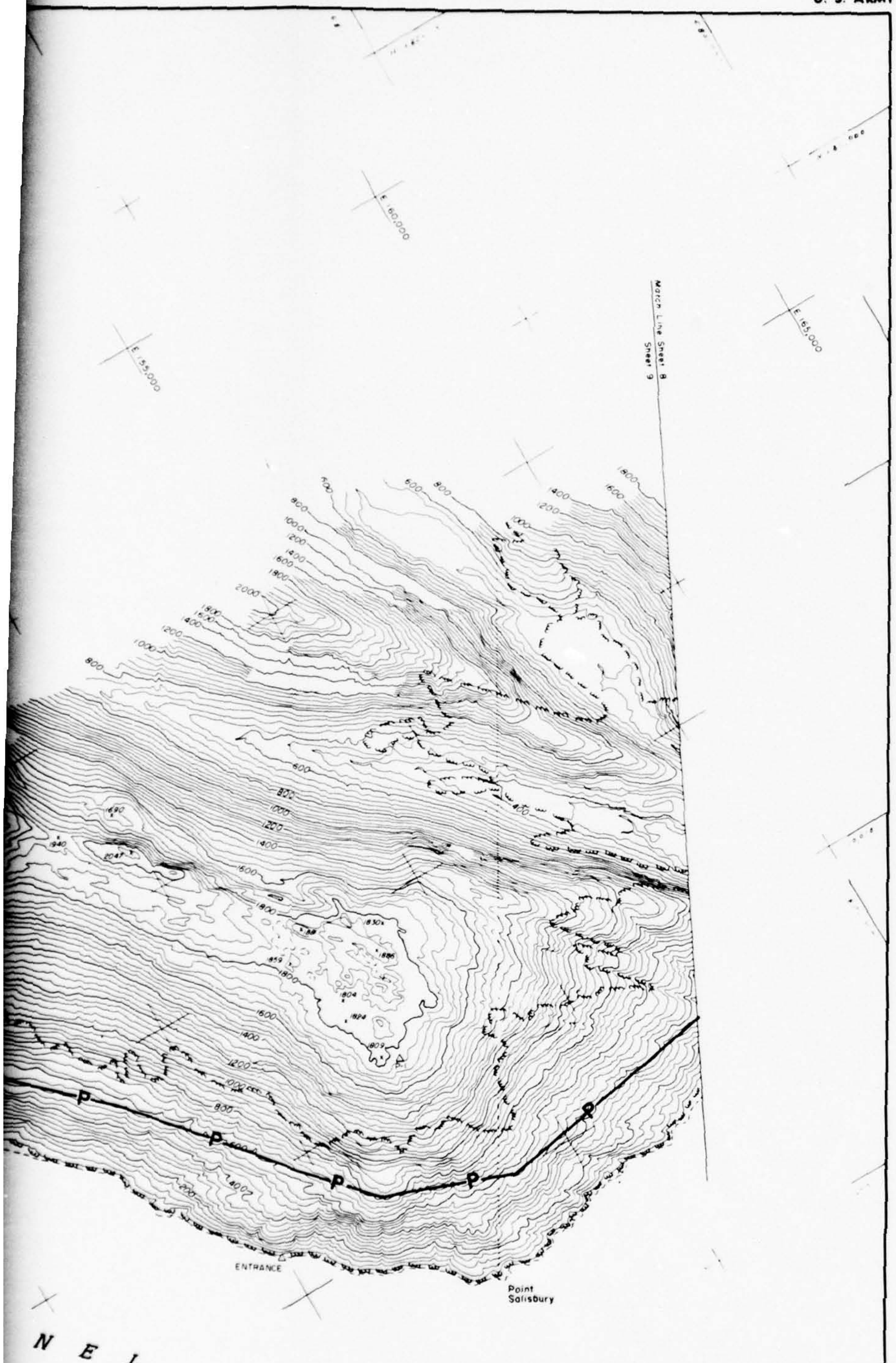
1000 0 1000 2000

LEGEND

Woodland

Snow or Ice

U. S. ARMY



U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: EASTL.	SNETTISHAM PROJECT, ALASKA
DRAWN: KH	
CHECKED: HS	FIRST STAGE DEVELOPMENT
PREPARED: EA.	TRANSMISSION LINE LOCATION

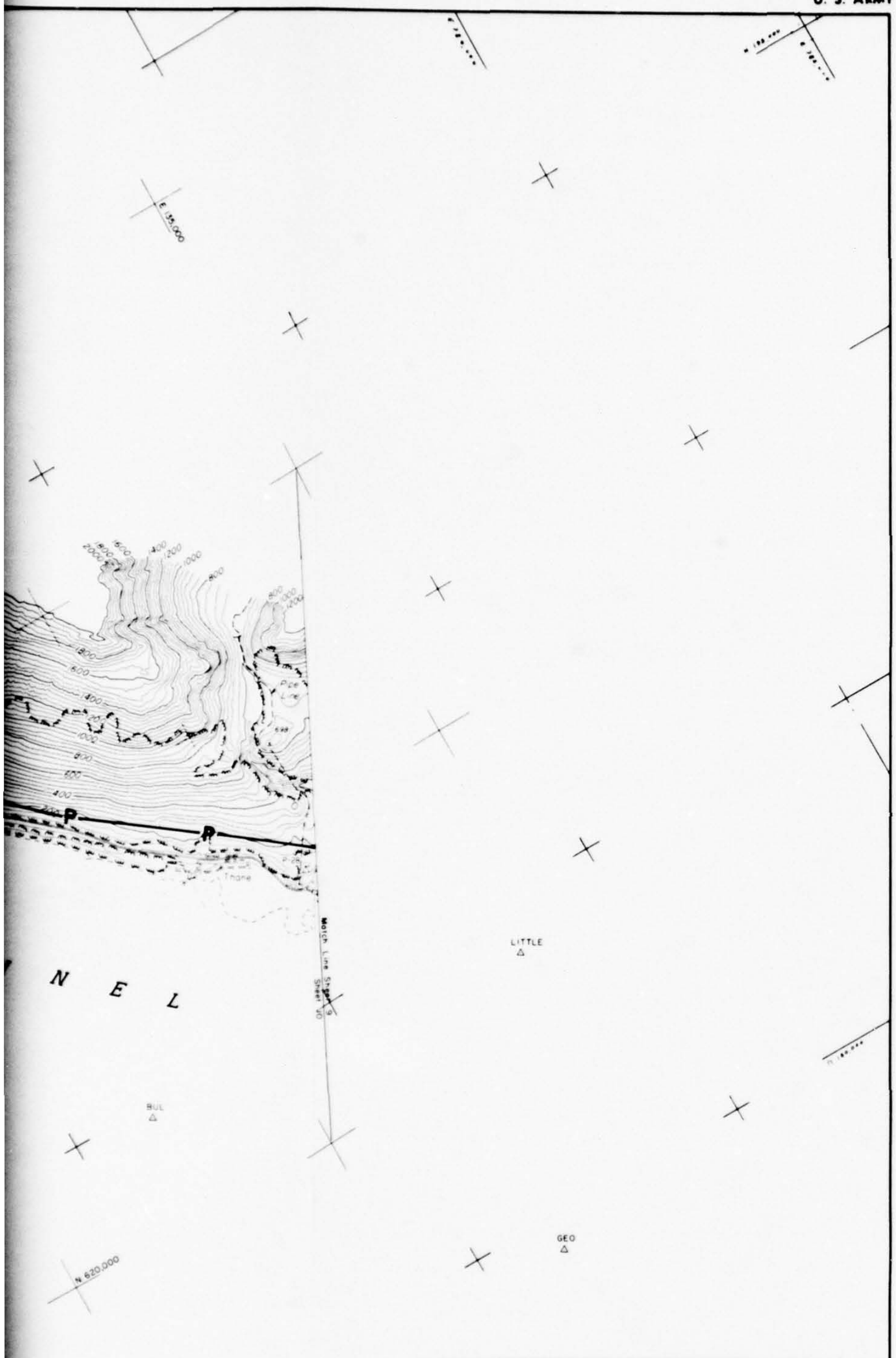
SUPERVISED: Henry Straub PE CHIEF, ADVANCED PLANNING SECTION	APPROVED: Clair F. Farley COLONEL, CE, DISTRICT ENGINEER	
SUBMITTED: CHIEF, PLANNING & REPORTS BRANCH	SCALE AS SHOWN	DATE 22 OCT, 1965
RECOMMENDED: Warren George CHIEF, ENGINEERING DIVISION	SHEET 9 OF	FILE NUMBER Q-4-5-113

DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE 9


Grid North
N 640,000
N 635,000
N 630,000
N 625,000
E 150,000
E 145,000
E 120,000
E 115,000
E 110,000
P-25
P-26
P-27
Rock
Dump
TRAM
G A S T I N E A U   C H A N
Juneau Substation
P
P
P
SCALE IN FEET
1000 0 1000 2000
LEGEND
Woodland
Snow or Ice

1

U. S. ARMY



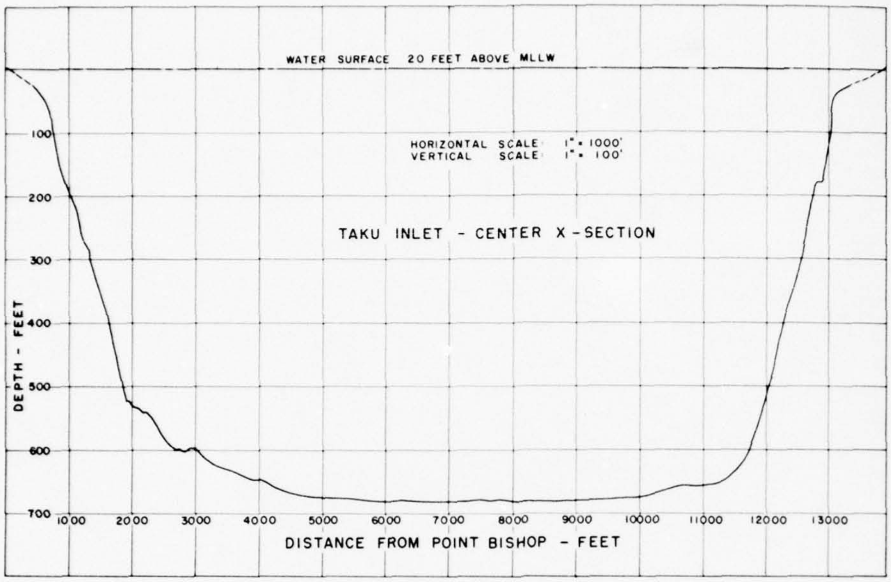
U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

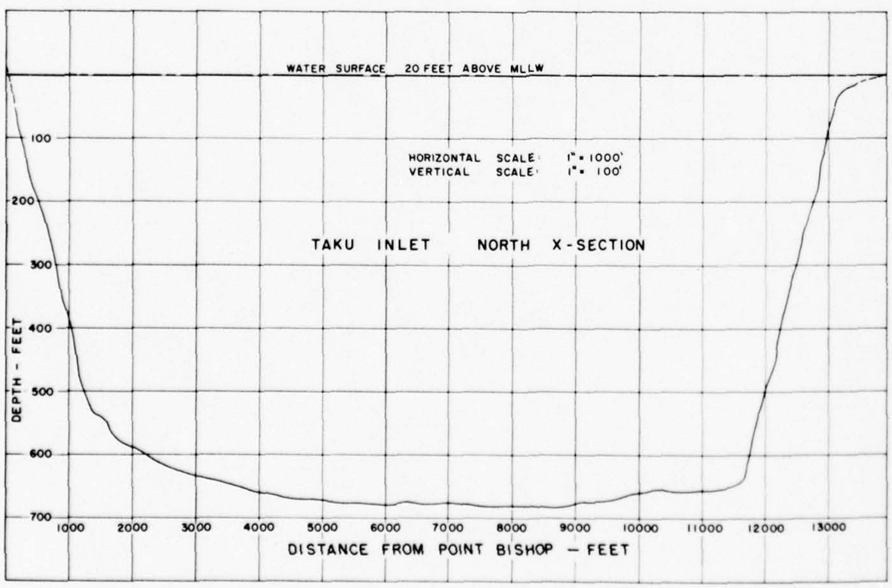
DESIGNED: EA & TL	SNETTISHAM PROJECT, ALASKA
DRAWN: TLS	FIRST STAGE DEVELOPMENT
CHECKED: HS	
PREPARED: EA	**TRANSMISSION LINE LOCATION**

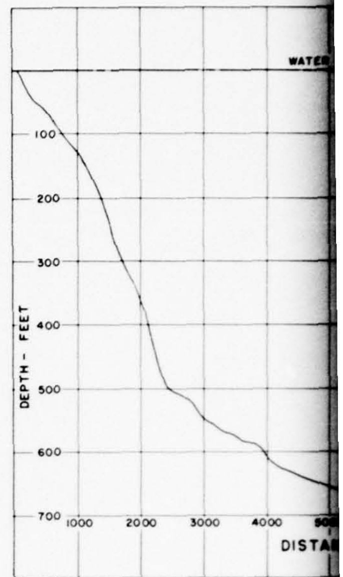
SUPERVISED: Henry Straub P.E.	APPROVED:
SUBMITTED:	SCALE: AS SHOWN — DATE 22 OCT., 1965
RECOMMENDED:	FILE NUMBER Q-4-5-113 — SHEET 10 OF

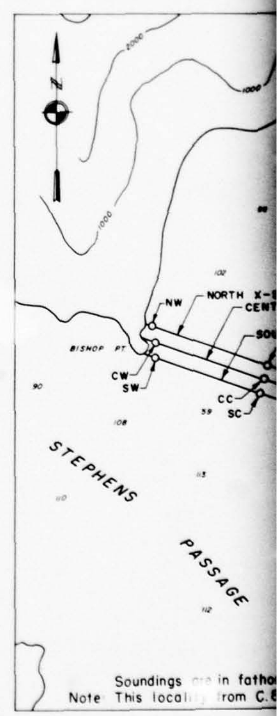
DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE 10

2

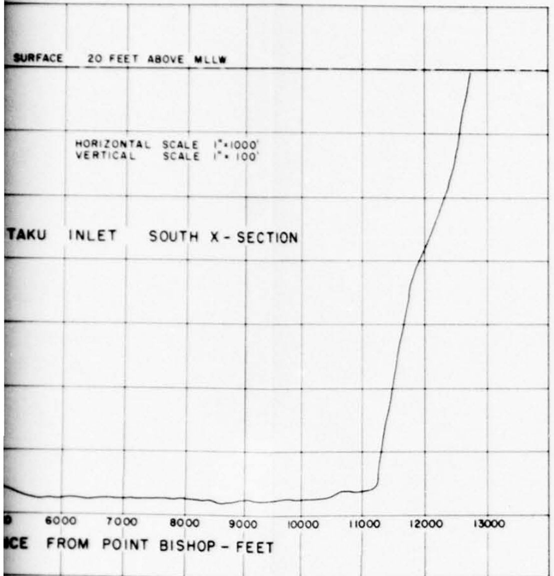

WATER SURFACE 20 FEET ABOVE MLLW
HORIZONTAL SCALE: 1" = 1000'
VERTICAL SCALE: 1" = 100'
TAKU INLET - CENTER X-SECTION
DEPTH - FEET
100
200
300
400
500
600
700
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000
DISTANCE FROM POINT BISHOP - FEET

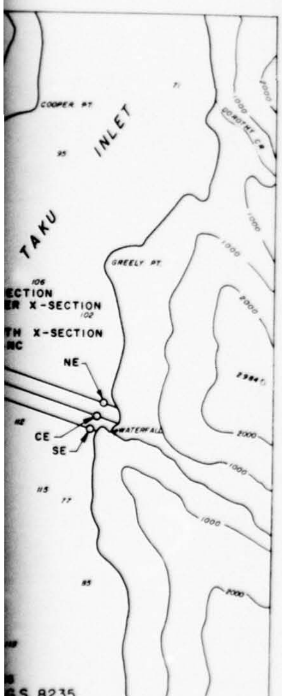

WATER SURFACE 20 FEET ABOVE MLLW
HORIZONTAL SCALE: 1" = 1000'
VERTICAL SCALE: 1" = 100'
TAKU INLET NORTH X-SECTION
DEPTH - FEET
100
200
300
400
500
600
700
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000
DISTANCE FROM POINT BISHOP - FEET


DEPTH - FEET
100
200
300
400
500
600
700
1000 2000 3000 4000


NW
BISHOP PT.
CW
SW
CC
SC
STEPHENS
PASSAGE

U. S. ARMY



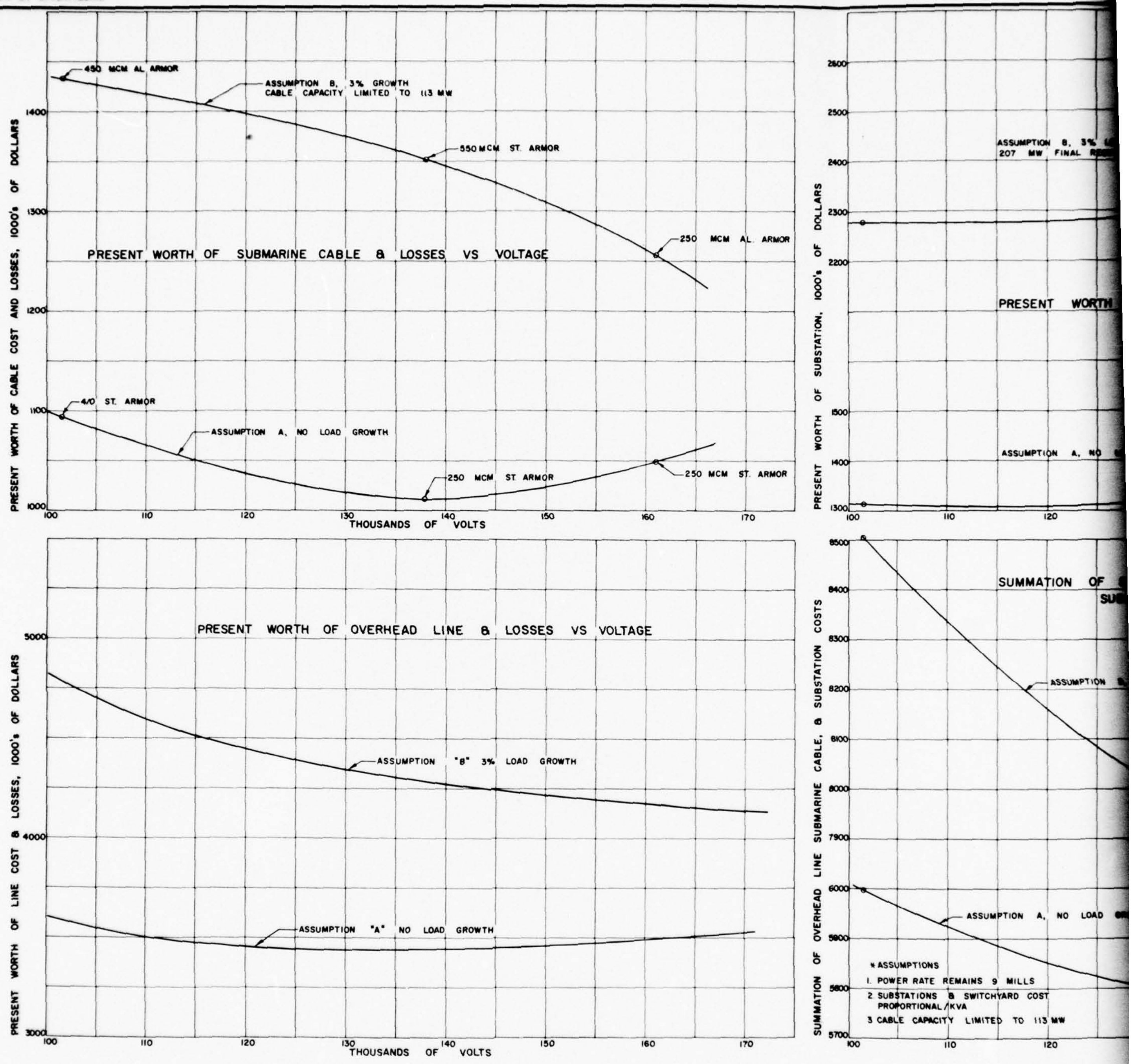


REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: EA&TL	SNETTISHAM PROJECT, ALASKA
DRAWN: PG	FIRST STAGE DEVELOPMENT
CHECKED: HS	
PREPARED: EA	**SUBMARINE CABLE PROFILE**
SUPERVISED: Henry Straub PE — CHIEF, ADVANCED PLANNING SECTION	APPROVED: — COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: — CHIEF, PLANNING & REPORTS BRANCH	SCALE AS SHOWN — DATE 22 OCT, 1965
RECOMMENDED: — CHIEF, ENGINEERING DIVISION	FILE NUMBER Q-4-5-113 — SHEET 11 OF

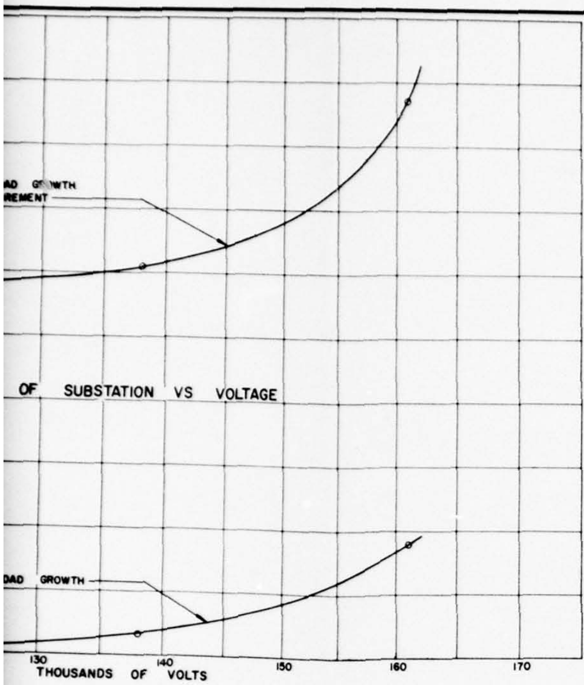
DESIGN MEMORANDUM NO. 7 APPENDIX B PLATE 11

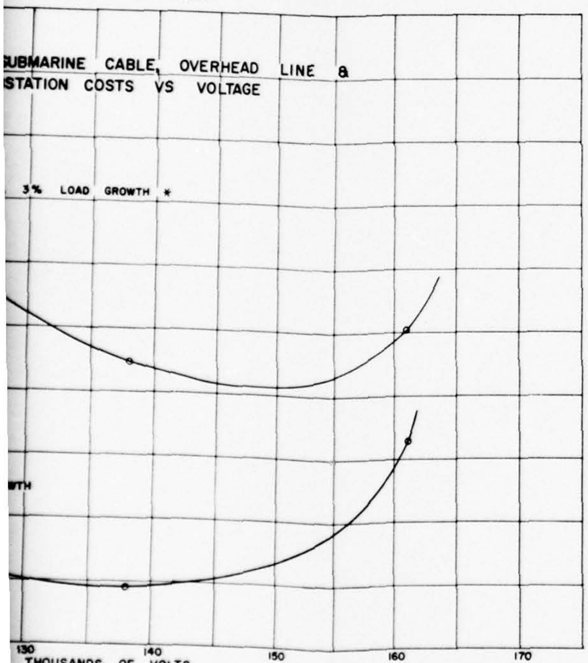


ASSUMPTION "A" - NO LOAD GROWTH AFTER POWER PLANT CAPACITY IS FULLY UTILIZED IN 13 YEARS.

ASSUMPTION "B" - FULL PLANT CAPACITY REACHED AT 13 YEARS, 3% PER YEAR GROWTH FOR 37 YEARS THERE AFTER. THIS UNREALISTICALLY LOW LOAD GROWTH WAS SELECTED TO ILLUSTRATE THE SHIFT TOWARD HIGHER VOLTAGE WITH GREATER LOAD.

U. S. ARMY





REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: T.L.	SNETTISHAM PROJECT, ALASKA
DRAWN: V.H.	FIRST STAGE DEVELOPMENT
CHECKED: HS	
PREPARED: TL & EA	COSTS VS VOLTAGE COMPARISONS

SUPERVISED: Henry Straub P.E. CHIEF, ADVANCED PLANNING SECTION	APPROVED: Chas B. Daley COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: CHIEF, PLANNING & REPORTS BRANCH	SCALE: AS SHOWN — DATE 22 OCT., 1965
RECOMMENDED: Warren George CHIEF, ENGINEERING DIVISION	SHEET 12 OF — FILE NUMBER Q-4-5-113

PHOTOGRAPHS

PHOTO # 1 - Typical type construction on A-J Industries 23kv line

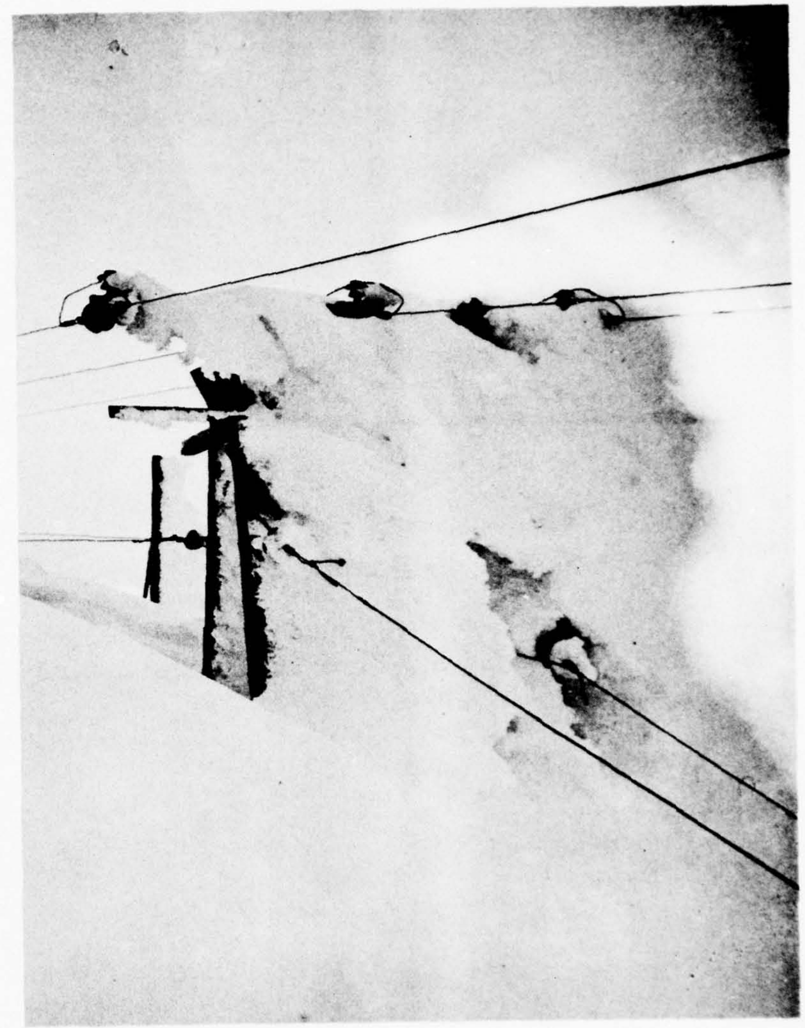


PHOTO # 2 - Snow and Ice formation on A-J Industries 23kv line

1183-66

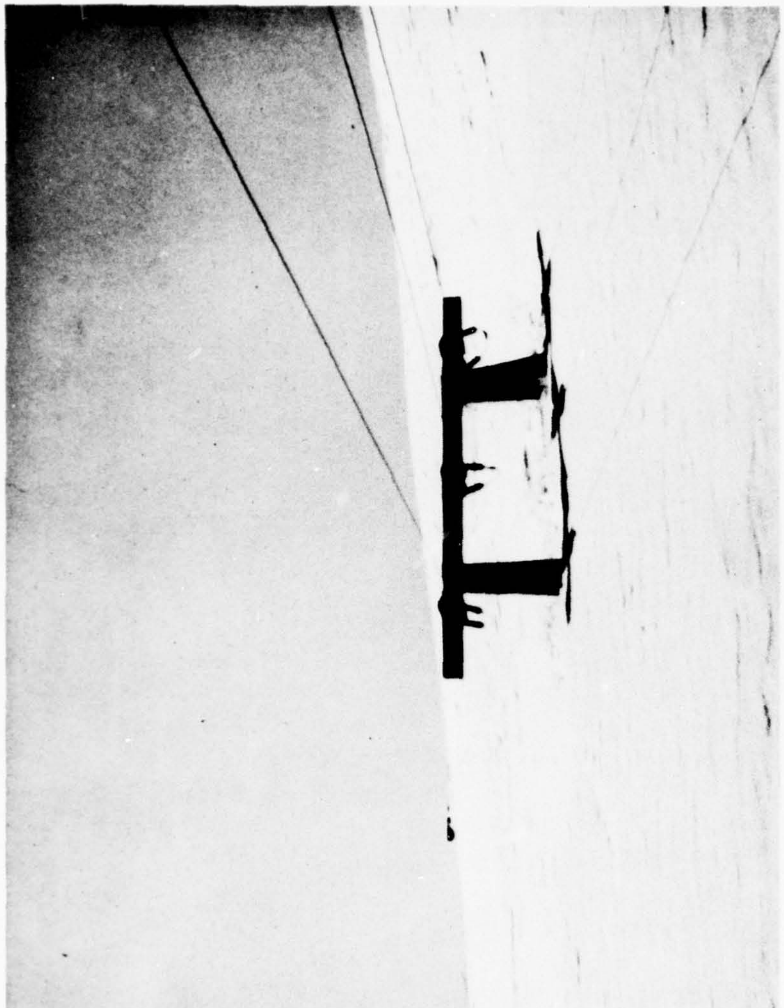


PHOTO # 3 - Conductor passing through drift on A-J Industries 23kv line

PHOTO # 4 - Emergency repairs to creep damaged structures on A-J Industries 23kv line

1183-66

APPENDIX C

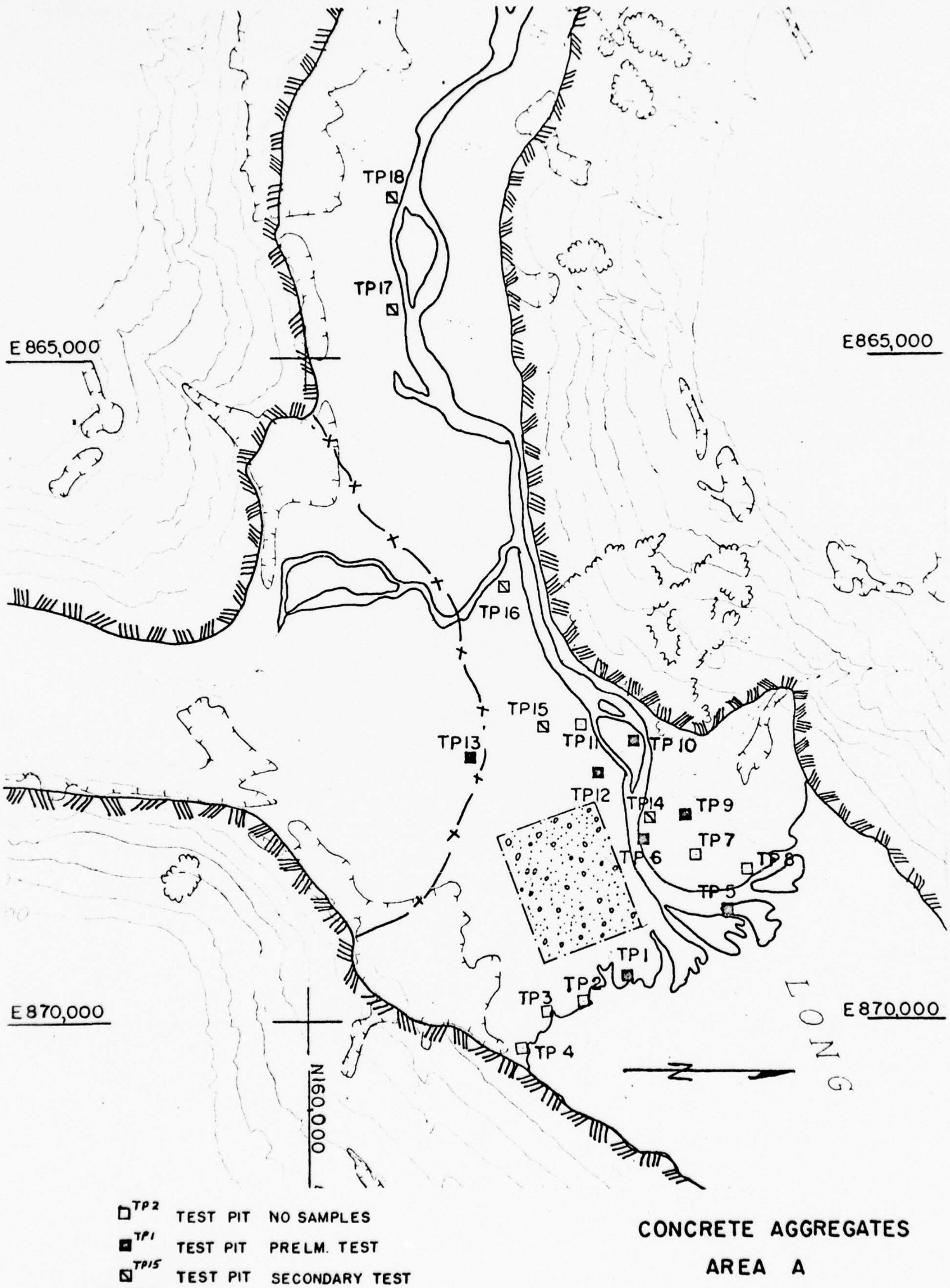
SNETTISHAM PROJECT, ALASKA

DESIGN MEMORANDUM NO. 7

Appendix C - Foundation and Material Data

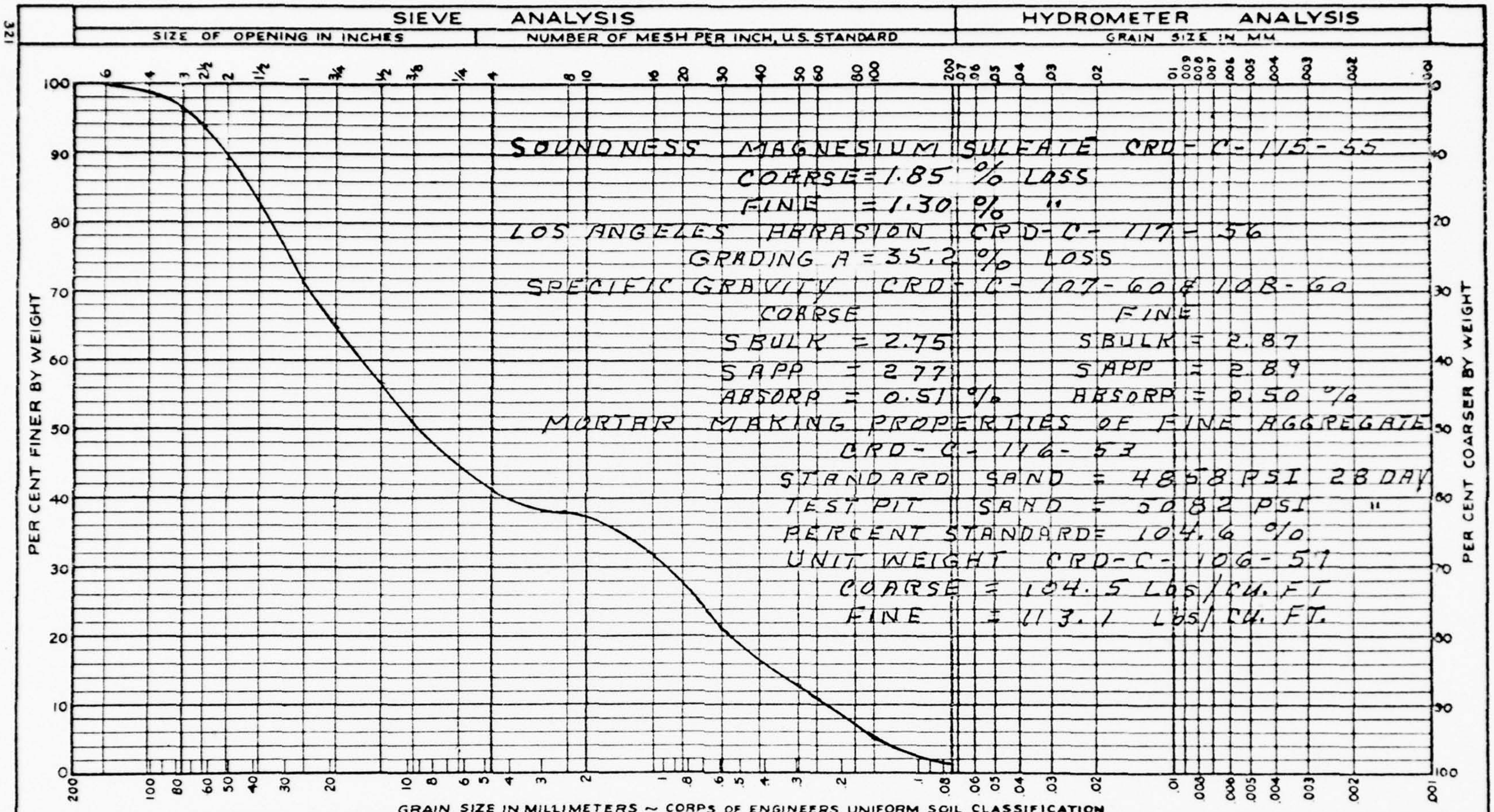
APPENDIX C

PART I CONCRETE AGGREGATE AREA A



TEST PIT NO SAMPLES (TP2)
TEST PIT PRELM. TEST (TP1)
TEST PIT SECONDARY TEST (TP15)
AREA OF DETAILED AGGREGATE STUDY
MORAINE FRONT EDGE

CONCRETE AGGREGATES
AREA A
1" = 1,000'



SOUNDNESS MAGNESIUM SULFATE CRD-C-115-55
COARSE = 1.85 % LOSS
FINE = 1.30 % "

LOS ANGELES ABRASION CRD-C-117-56
GRADING A = 35.2 % LOSS

SPECIFIC GRAVITY CRD-C-107-60 & 108-60

COARSE	FINE
SBULK = 2.75	SBULK = 2.87
SAPP = 2.77	SAPP = 2.89
ABSORP = 0.51 %	ABSORP = 0.50 %

MORTAR MAKING PROPERTIES OF FINE AGGREGATE
CRD-C-116-53
STANDARD SAND = 4858 PSI 28 DAY
TEST PIT SAND = 5082 PSI "
PERCENT STANDARD = 104.6 %

UNIT WEIGHT CRD-C-106-57
COARSE = 104.5 LBS/CU. FT
FINE = 113.1 LBS/CU. FT.

COBBLES	GRAVEL: Coarse	GRAVEL: Fine	SAND: Coarse	SAND: Medium	SAND: Fine	FINES

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI	
		SANDY GRAVEL GP-NFS				Wt = 1283.2 lbs.

PROJECT SNETTISHAM
Sample data CONCRETE AGGREGATE HEAD OF LONG LAKE TP-14
Submitted by F&M BR GEOLOGY
Expl. or gp. sample No
W/O No. 526-65
24 June 65 (Date of report)
D. L. Gard
Chief, Soil Mechanics Branch

NPD FORM 321
JAN 1951

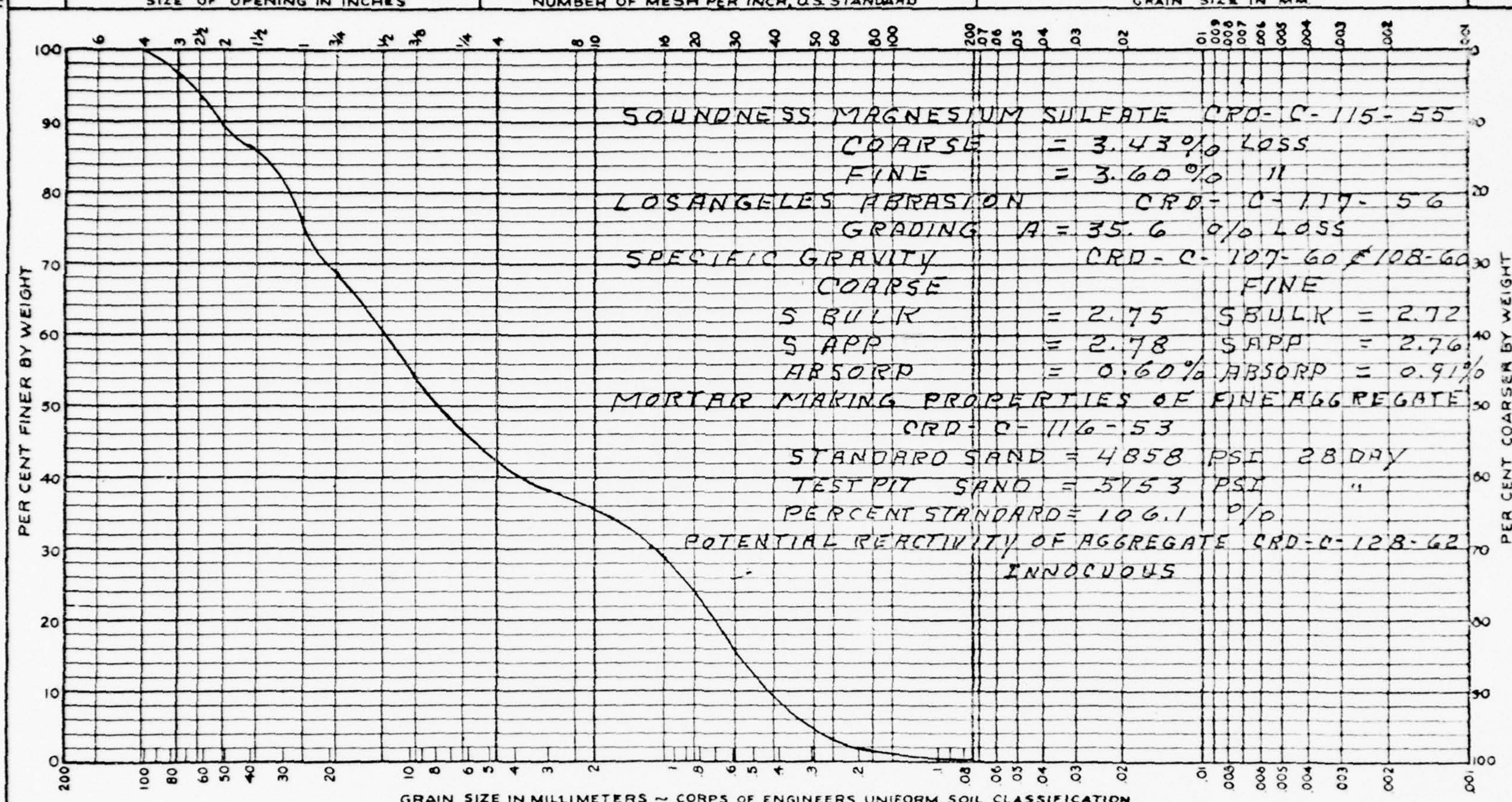
GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: OLG
Checked:

321

SIEVE ANALYSIS — SIZE OF OPENING IN INCHES — NUMBER OF MESH PER INCH, U.S. STANDARD | HYDROMETER ANALYSIS — GRAIN SIZE IN MM



COBBLES	GRAVEL: Coarse	GRAVEL: Fine	SAND: Coarse	SAND: Medium	SAND: Fine	FINES

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	L L	P I	
		SANDY GRAVEL				
		GP-NFS			WT	642.9 lbs.

PROJECT SNETTISHAM

Sample data CONCRETE AGGREGATE

HEAD OF LONG LAKE TP-15

Submitted by F&M GEOLOGY

Expl. or gp. sample No

W/O No. 526-65

24 June 65 (Date of report)

D L Ford — Chief, Soil Mechanics Branch

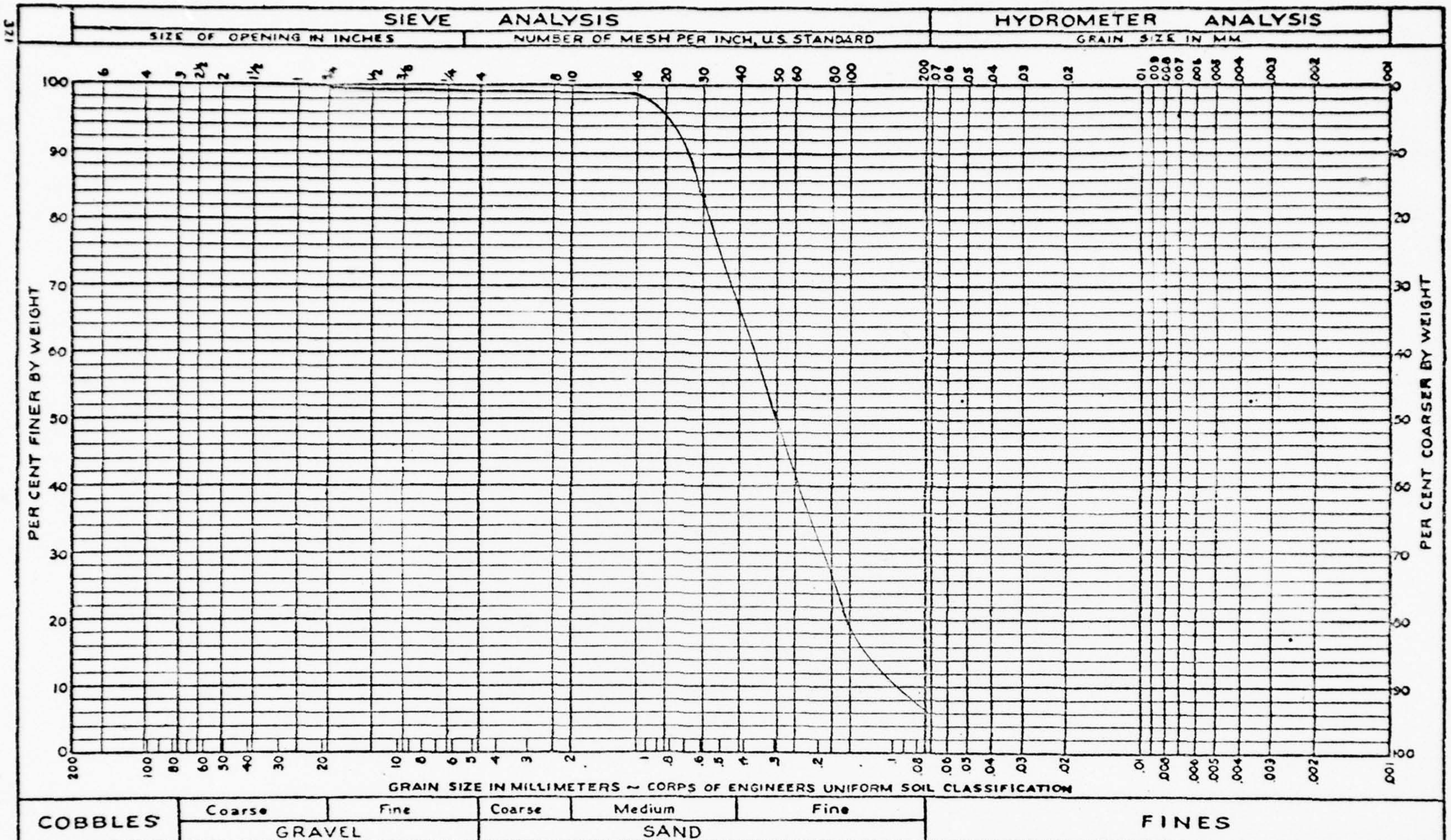
NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: DLG

Checked:



SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	LL	PI	
1	0.0-4.0	SILTY SAND				
		SP-SM-F1			WT=	63.1 Lbs

PROJECT	SNETTISHAM
Sample data	CONCRETE AGGREGATE
	HEAD OF LONG LAKE TP-16
Submitted by	F&M GEOLOGY
Expl. or gp. sample No.	
W/O No.	526-65
24 June 65 (Date of report)	D L Clark, Chief, Soil Mechanics Branch

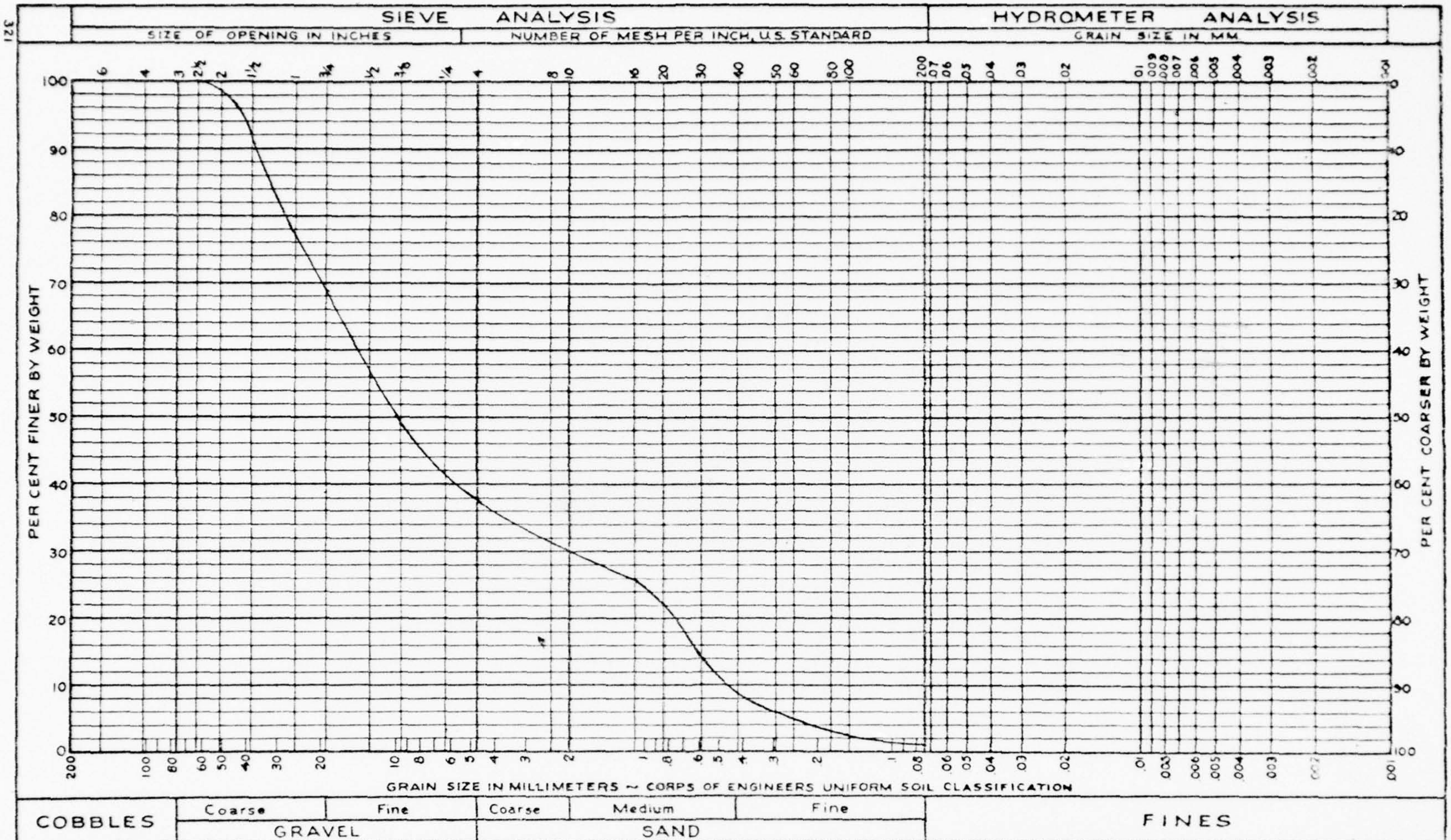
NPD FORM 321
JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: DLG
Checked:

321



SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI	
1	0.0 - 3.5	SANDY GRAVEL GP NFS				WT = 135.0 Lbs.

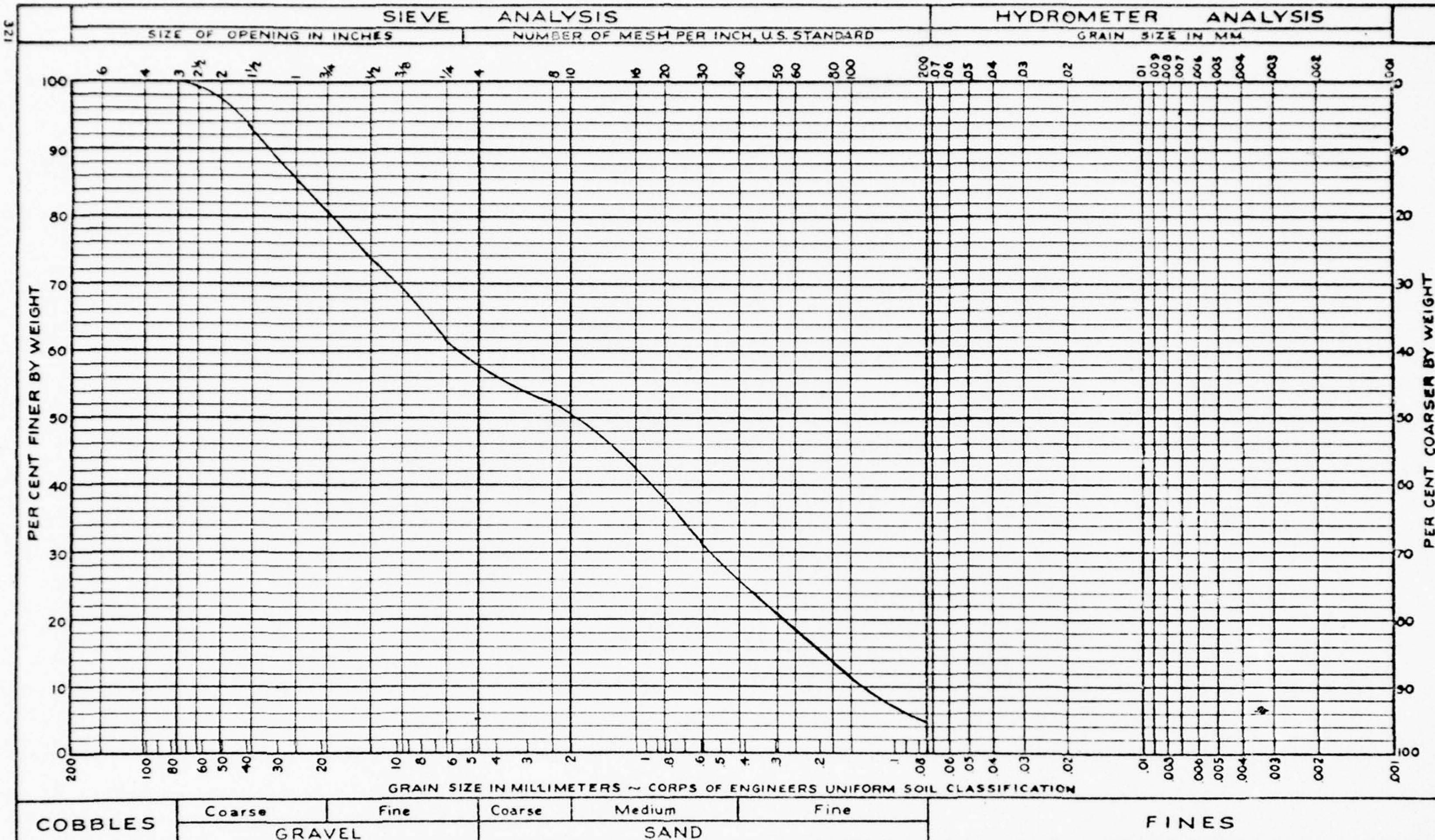
PROJECT SNETTISHAM
Sample data CONCRETE AGGREGATE HEAD OF LONG LAKE TP-17
Submitted by F&M GEOLOGY
Expl. or gp. sample No
W/O No. 526-65
24 June 65 (Date of report)

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: DLG
Checked:



SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI	
1	1.5 - 3.5	SILTY GRAVELLY SAND SP-SM-NFS			WT = 357.0 Lbs	

PROJECT SNETTISHAM
Sample data CONCRETE AGGREGATE
HEAD OF LONG LAKE TP-18
Submitted by F&M GEOLOGY
Expl. or gp. sample No
W/O No. 526-65
24 June 65 (Date of report)
[signature] Chief, Soil Mechanics Branch

NPD FORM 321 JAN 1951

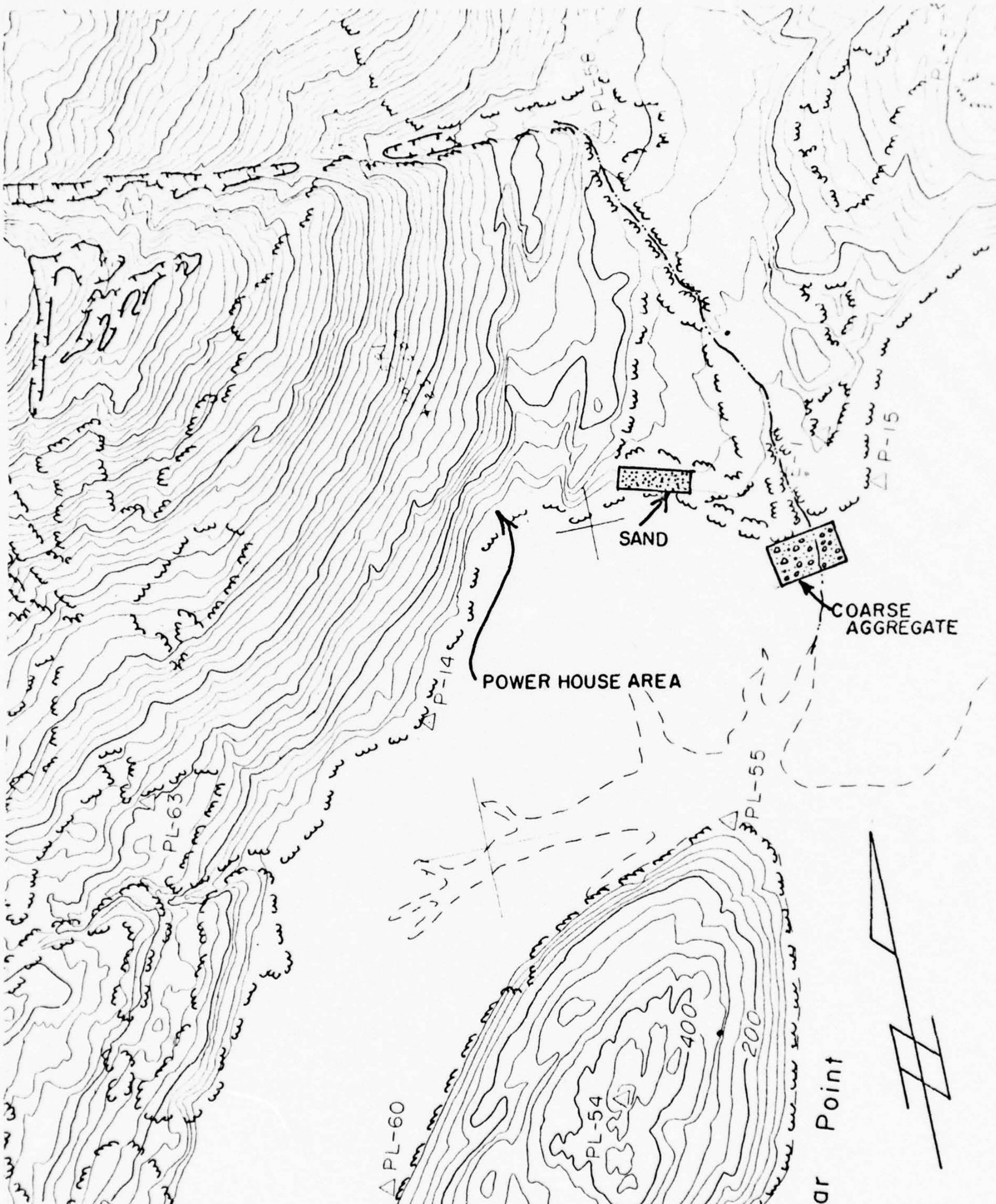
GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: DLG
Checked:

321

PART 2 CONCRETE AGGREGATE AREA B

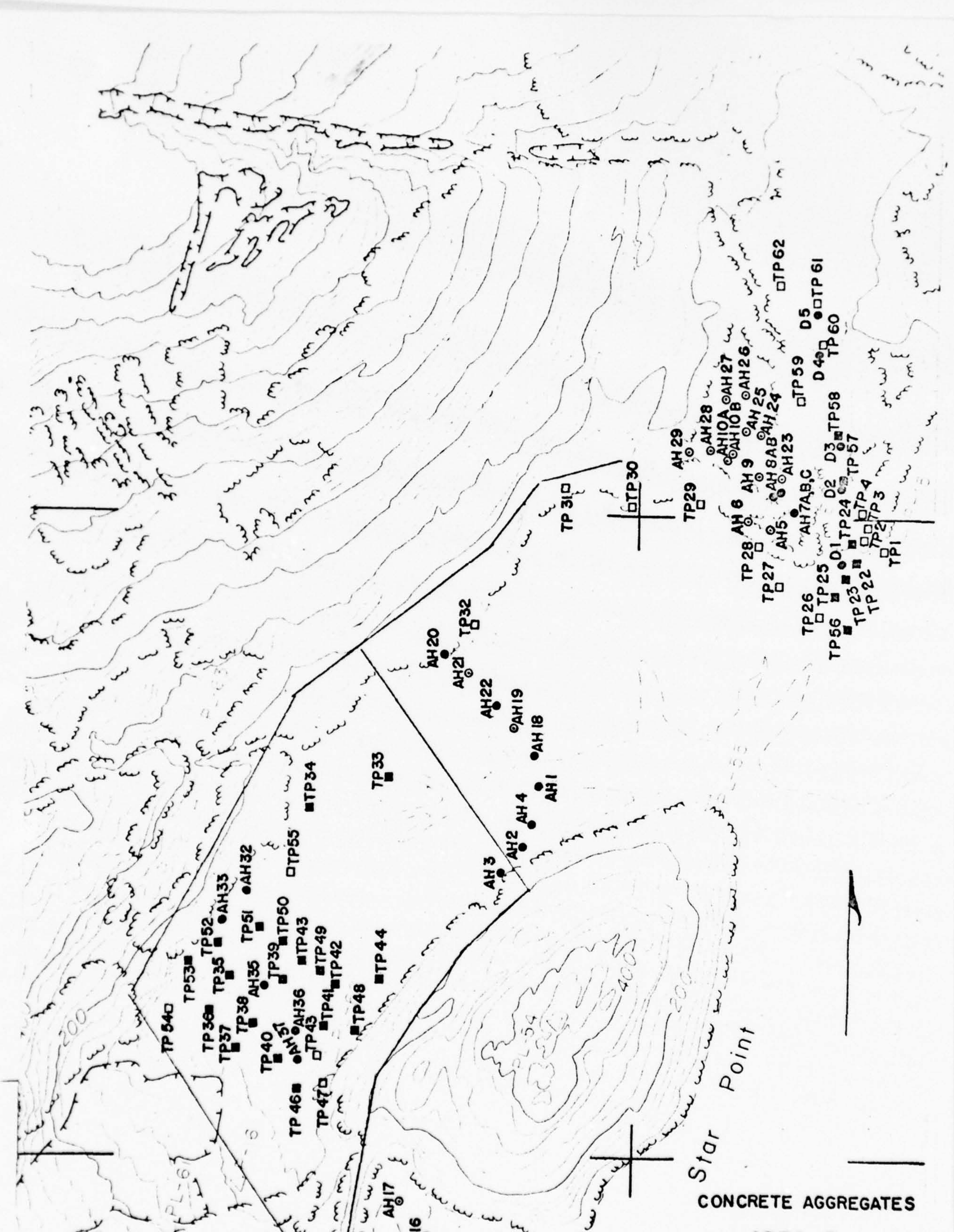


CONCRETE AGGREGATES

AREA B

Areas selected for development

1"= 1,000'



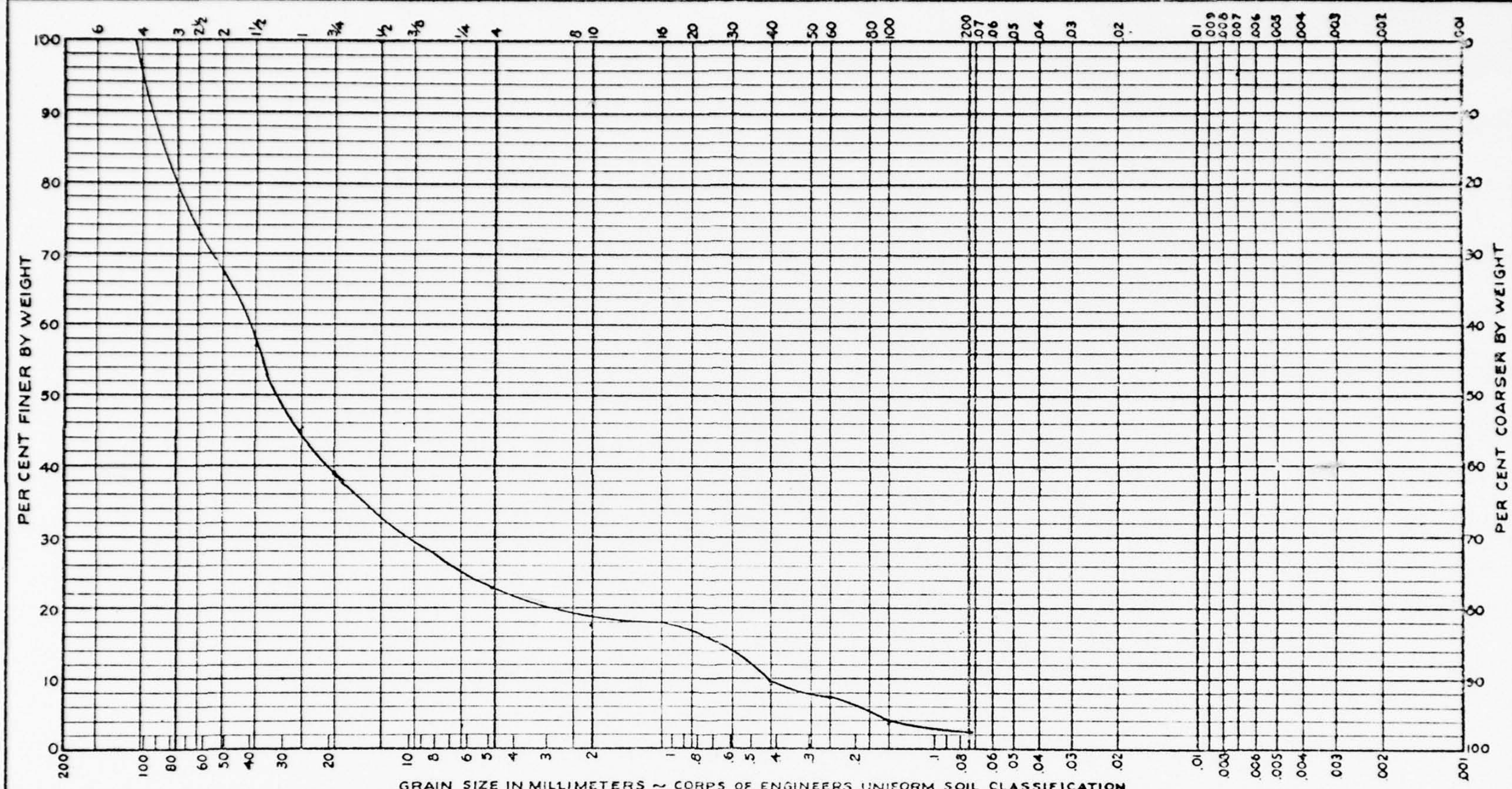
CONCRETE AGGREGATES

AREA B

Locations of test pits and auger holes

1" = 1,000'

321



COBBLES	GRAVEL: Coarse	GRAVEL: Fine	SAND: Coarse	SAND: Medium	SAND: Fine	FINES

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI	
		Sandy Gravel				Wt = 122.3 Lbs
		GP- N.f.S				

PROJECT Snettisham
Sample data GLacier Greek
TP 56
Submitted by GeoLogy
Expl. or gp. sample No
W/O No. 526-65

NPD FORM 321
JAN 1951

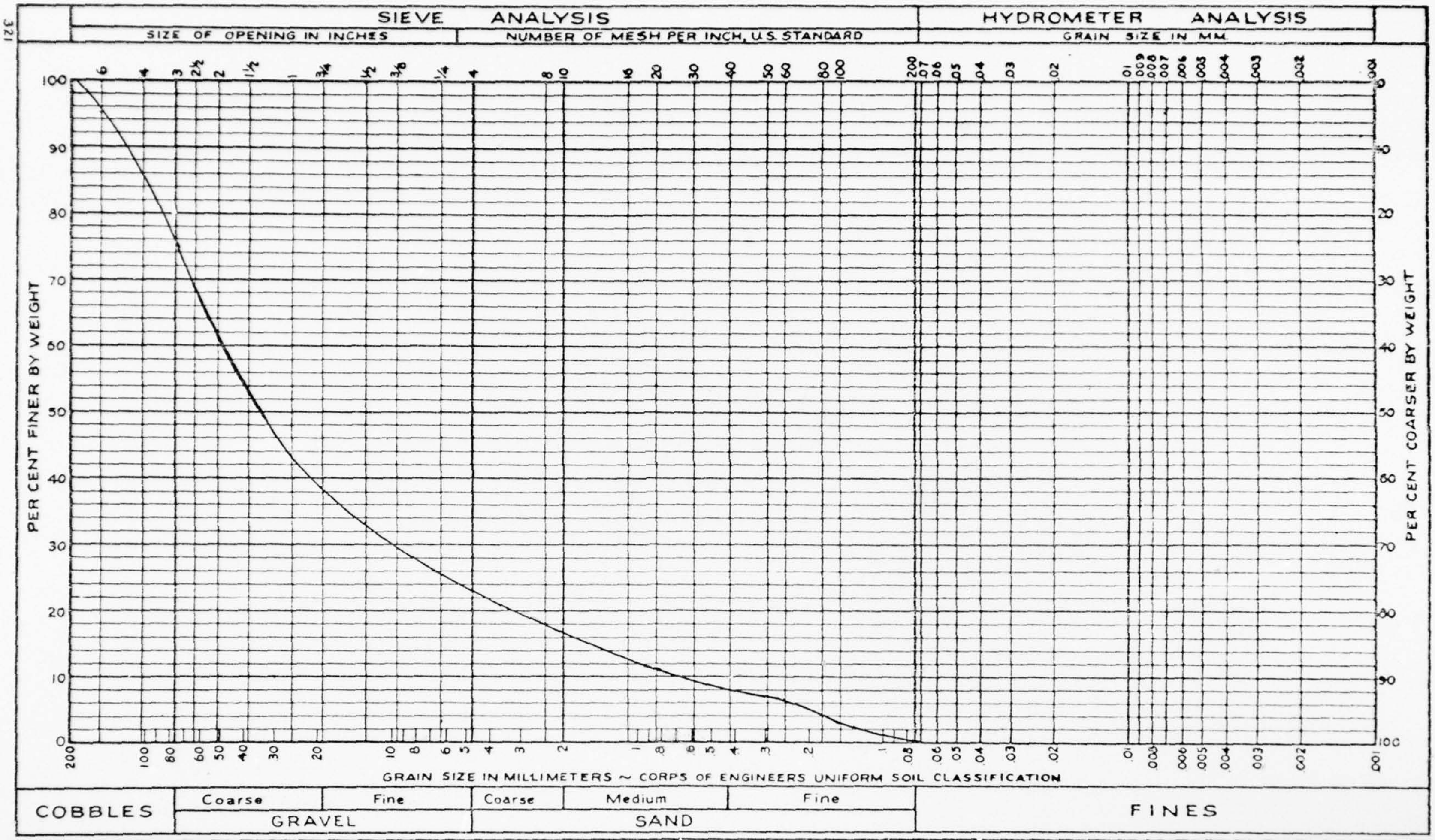
GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted [signature]
Checked [signature]

14 may 65
(Date of report)

[signature]
Chief, Soil Mechanics Branch



SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI	
		Sandy Gravel				wt. 268+ Lbs
		GP- N.F.S				

PROJECT Snettisham
Sample data Glacier Creek
TP-57
Submitted by Geology
Expl. or gp. sample No
W/O No. 526-65

NPD FORM 321
JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: [illegible]
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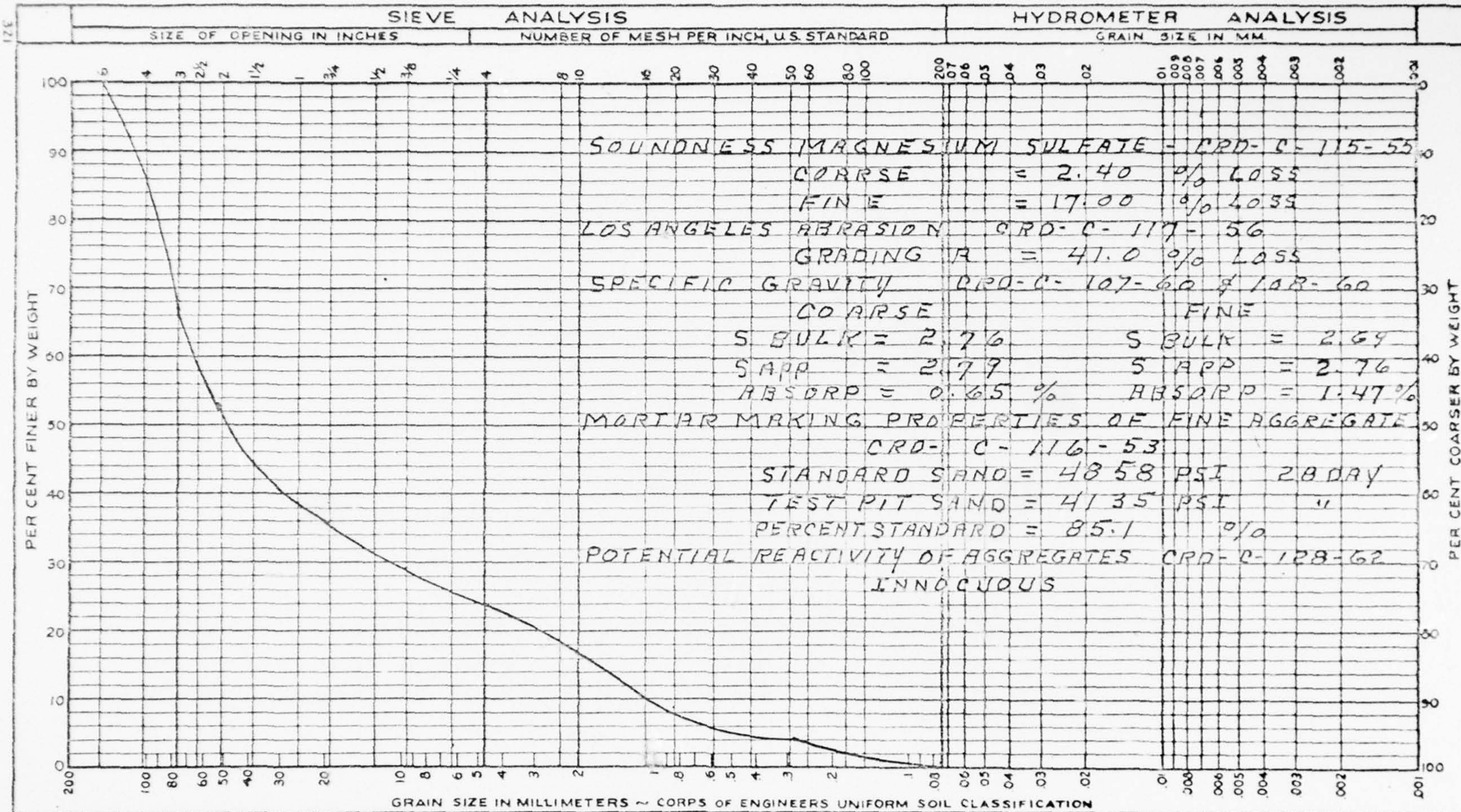
14 May 65
(Date of report)

[illegible]
Chief, Soil Mechanics Branch

321



COBBLES	GRAVEL: Coarse	GRAVEL: Fine	SAND: Coarse	SAND: Medium	SAND: Fine	FINES

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI	.
		Sandy Gravel				Wt 327.4 Lbs
		GP-NFS				

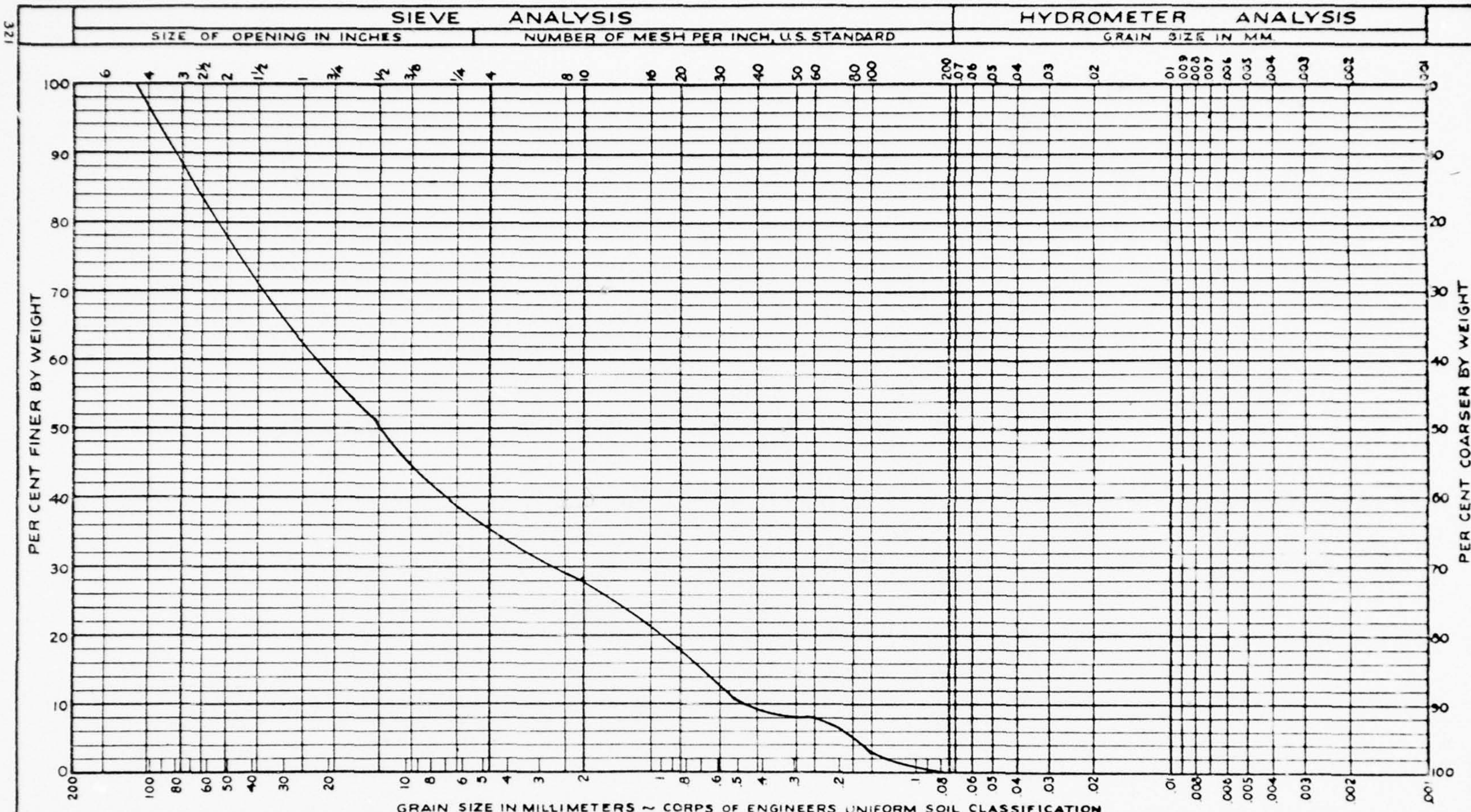
PROJECT Snettisham
Sample data Glacier Creek
TP-58
Submitted by Geology
Expl. or gp. sample No
W/O No. 526-65
14 May 65 (Date of report)
[signature] Chief, Soil Mechanics Branch

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: [initials]
Checked: [initials]



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI	
		Sandy Gravel				wt = 116.7 Lbs
		GP- N.F.S.				

PROJECT SNettisham
Sample data Glacier Creek
TP-60
Submitted by Geology
Expl. or gp. sample No
W/O No. 526-65

NPD FORM 321
JAN 1951

GRADATION CURVES

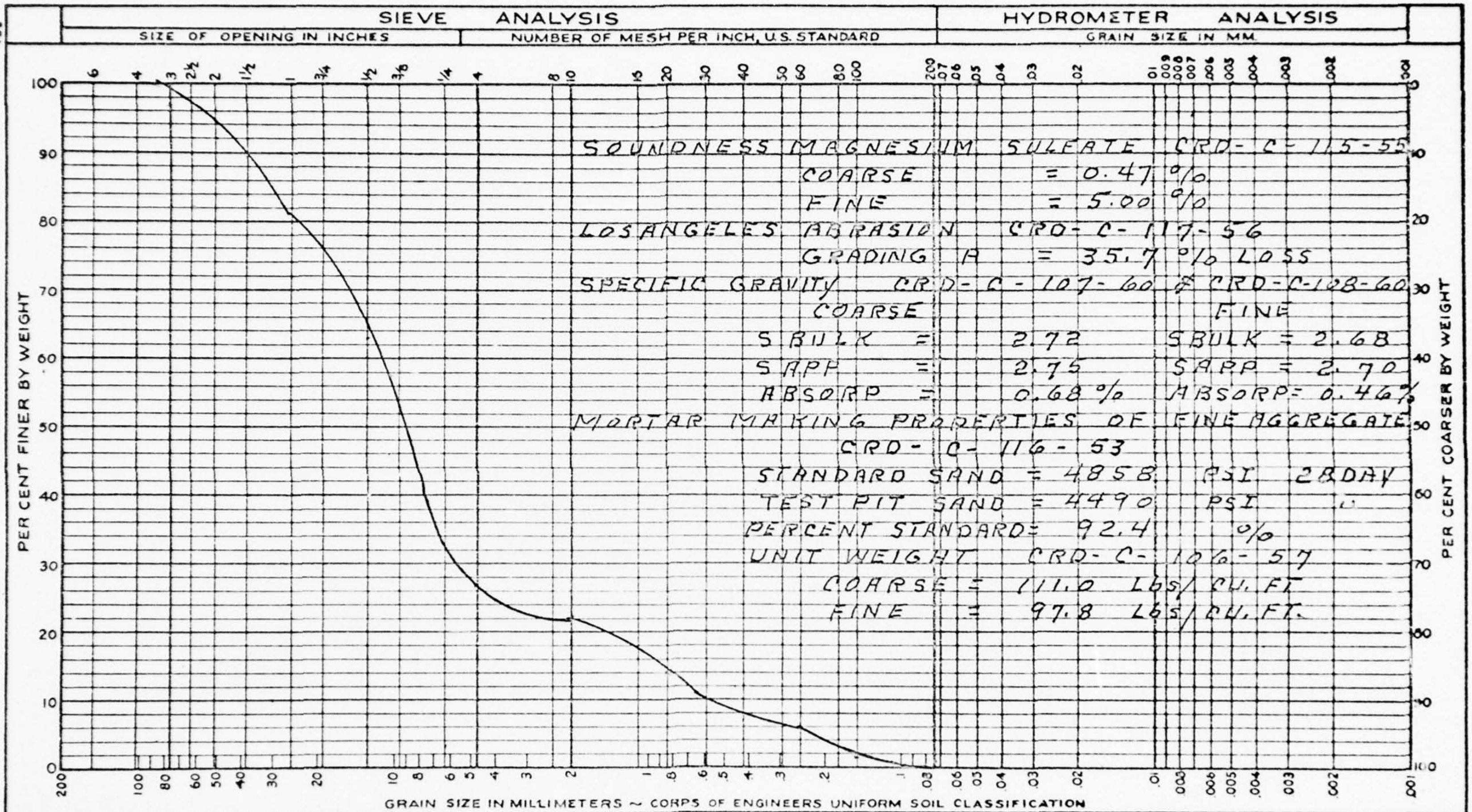
CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted:
Checked:

14 May 65
(Date of report)

Chief, Soil Mechanics Branch

321



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI		
		Sandy Gravel				wt. 120.6 Lbs.	PROJECT Snettisham
							Sample data Glacier Creek
		GP - NFS					TP 63
							Submitted by Geology
							Expl. or gp. sample No
							W/O No. 526-65

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: [signature]
Checked: [signature]

14 May 65
(Date of report)

[signature]
Chief, Soil Mechanics Branch

321

PART 3 CONCRETE AGGREGATE - PETROGRAPHIC A & B

ADDRESS REPLY TO
DIRECTOR
(NOT TO INDIVIDUALS)

U. S. ARMY ENGINEER DIVISION, NORTH PACIFIC
CORPS OF ENGINEERS
NORTH PACIFIC DIVISION MATERIALS LABORATORY
RT. 2. BOX 12A
TROUTDALE, OREGON

NPDEN-GS-L (65-P-81) 19 August 1965

SUBJECT: Petrographic Analysis of Snettisham Project Natural Aggregates

TO: District Engineer
U. S. Army Engineer District, Alaska
ATTN: NPAEN-FM-G

1. Reference is made to:

a. Your Disposition Form dated 19 May 1965 requesting petrographic tests on natural aggregates from Long Lake, Glacier Creek and Crater Creek test pit sources.

b. Telephone conversation your Mr. Dixon and our Mr. Higgs on 4 August 1965 wherein it was agreed that only 3/4"-#4 and sand nominal sizes of all samples be tested because of insufficient amounts of plus 3/4" materials.

2. Inclosed and completing all work requested by above reference 1a is petrographic report containing test results on five test pit samples from Glacier Creek, Crater Creek and Long Lake sources.

2 Incl (in dupe)
1. Petro Rpt
2. Tabulations (I and II)

J. L. Bargar
J. L. BARGAR
Director

CORPS OF ENGINEERS, U S ARMY OFFICE OF THE DIVISION ENGINEER NORTH PACIFIC DIVISION 500 PITTOCK BLOCK PORTLAND 5, OREGON NPD TESTING LABORATORY		PETROGRAPHIC REPORT		
		DATE AUG 19 1965	EXPL. NO	SAMPLE NO Test Pits 33, 34, 58, 63 & 64
		PETROGRAPHER N. B. Higgs		W/O NO 65-P-81
SAMPLED BY District Personnel SUBMITTED BY (DIST OR AGENCY) Alaska District	PROJECT Snettisham Project, Juneau, Alaska	SOURCE Natural Sand and Gravel from Test Pits TP-33 and TP-34, Crater Creek; TP-58 and TP-63, Glacier Creek; and TP-64, Long Lake.		

1. Samples and Tests

Natural sand and gravel material from test pit excavations TP-64 near Long Lake, TP-58 and TP-63 near Glacier Creek, and TP-33 and TP-34 near Crater Creek were quartered, prescreened into separate screen sizes, and then samples from the separated screen fractions were tagged in small bags that were placed by test pit designation in five large sack samples and shipped to NPD Materials Laboratory for a brief petrographic examination (P-A-16). Although gravel sizes up to four inch were present in samples submitted, examination of material from each of the five pit sources revealed that insufficient plus 3/4" material was available for petrographic testing; therefore, and as agreed to by Alaska District personnel, only 3/4"-#4 and sand nominal sizes of material were tested. Test method CRD-C-127, Examination of Aggregates for Concrete, requires that 300 particles per screen fraction of gravel materials be examined for reliable results. Approximate minimal weights of materials required for 300 particles in screen fractions up to the 2"-1½" are indicated on page 10 of this test method under note to paragraph 4 (a). Attached tabulation sheet I contains percent constituents per screen fraction of gravels from the five test pit sources and footnoted thereto are the screen fractions that contained amounts of materials less than recommended by CRD-C-127. As the gravels were prescreened prior to submittal, arithmetic averages rather than weighted average percentages based upon gradation of materials were used in computing total composition of each gravel sample. Field gradations along with given percentages of fraction data can be used to compute weighted average percent compositions as desired. The submitted sand samples from the test pits had been prescreened and preweighed to sand screen sizes other than those usually used for concrete sand gradations; therefore, all sand materials from each test pit were composited and rescreened so that examination could be performed on standard screen size fractions. Contained in tabulation II are the weighted average percent constituents in five sand samples as computed using percent retained figures obtained from near the midpoint of the percent retained range for screen sizes given in standard civil works concrete sand specification gradations and at a fineness modulus of 2.77. Soft particles in gravels were determined by test method CRD-C-130 and the NPD Red Devil Shaker test was used to find amounts of soft constituents in sands. Over-all view is that amounts of materials examined are considered sufficient for a brief petrographic examination of investigatory materials and, although samples are insufficient for a complete petrographic analysis, the data now gleaned should serve as a basis for tentative comparisons of current and future samples. A large bulk sample of natural sand and gravel materials is now being obtained at Snettisham Project and this sample should furnish detailed petrographic data.

INCL 1

PETROGRAPHIC REPORT (CONTINUED)	DATE AUG 1 9 1965	EXPL. NO	SAMPLE NO Test Pits 33, 34, 58, 63 & 64
	PETROGRAPHER N. B. Higgs		W/O NO 65-P-81

2. Composition

a. Gravels: All five samples consist essentially of granitic stones and represent glacial out-wash gravels derived from granite rocks of the Coast Range batholith. These granite rocks form a major portion of the country rock at Snettisham project and at Long Lake Damsite the granite is a quartz diorite that commonly has a gneissoid or gneissic structure with randomly alternating, subparallel, light and dark colored bands or laminations containing varying proportions of quartz, feldspar, hornblende and biotite mica minerals. The variably foliated nature of these granitic rocks is shown in the photograph to Exhibit I of Design Memorandum No. 3, Selection of Plan of Development, Snettisham Project, Alaska. The white bands in the foliated granite consist primarily of equidimensional quartz and feldspar with minor dark minerals; whereas, the darker colored bands contain dark platy biotite mica and tubular to prismatic hornblende as well as the equidimensional quartz-feldspar minerals. As the gravels submitted are derived from similar gneissoid granitic rocks, the rock types present in the samples represent specific portions of granite foliations, dike and vein materials, and associated metamorphics and cataclastites. Quartz-feldspar rock consists of fine grained vein and aplite dike material, medium to coarse grained white rock from foliation bands and an occasional coarse grained pegmatitic stone. Quartz-feldspar rocks all contain less than 10% of dark-colored biotite-hornblende minerals. Light-colored, speckled black and white, granite rocks of attached tabulation I are the typical granite materials from the batholith. They are prevailing medium to coarse grained and by megascopic examination contain less than 30% and more commonly less than 20% of dark biotite-hornblende minerals. Quartz-feldspar and light-colored granite stones both show only slight foliation. Dark-colored biotite hornblende rocks are derived chiefly from the darker colored bands in foliated intervals of the granite, contain dark minerals in amounts greater than 30%, and are prevailing fine grained. Stones having a distinct gneissose to schistose foliated structure are concentrated in the dark-colored biotite-hornblende fraction and average about 28% and 29% of test pits 34 and 58 and less than 20% of the other test pit materials. Easily split or cleaved chlorite-talc, mica, or quartz-mica schists were not observed in any of the gravel samples. The dark biotite-hornblende rock represents schistose intervals in the gneissoid granite and these stones in sample are of hard and non-splittable type. Miscellaneous particles include hornfel and granulite metamorphic stones, epidosite granites, vein metamorphic materials and a few hard cataclastic breccia stones. The minor amounts of dark, fine grained basalt particles found in samples is similar to basalt dike material in a core segment previously from foundation material at Long Lake Damsite. A few of the basalt and possibly some of the miscellaneous stones may be meta-graywacke, however, thin section studies would be required for positive identification. Test pits 58 of Glacier Creek and 34 of Crater Creek contain greater amounts of biotite-hornblende rock; otherwise, compositions of test pit samples are similar. Gravels of Long Lake Test Pit 64 have the least variable lithology and consist essentially of light-colored granite stone.

PETROGRAPHIC REPORT (CONTINUED)	DATE AUG 1 9 1965	EXPL. NO.	SAMPLE NO. Test Pits 33, 34 58, 63 & 64
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b. Sand: Except for discrete minerals derived from disintegration of constituent rock types, the sands are all similar in composition to the gravels and of granitic lithology. Only significant variations in composition between sand samples is the greater amounts of dark-colored biotite-hornblende rock in TP-34 of Crater Creek and TP-58 of Glacier Creek (see tabulation II). The gravels from these test pits also contained greater amounts of this type material, however, quantites of biotite-hornblende rock in sands from these two test pits are substantially less than in the gravels. Discrete hornblende exceeds discrete biotite grains in all sand samples and test pits with greater amounts of biotite-hornblende rock have discrete hornblende two to three times as abundant as biotite mica flakes. Discrete biotite and hornblende together comprise between 10 and 20 percent of a sample and occur primarily in material passing the No. 30 sieve. Mica flakes are most abundant in material passing the No. 100 sieve size. Plagioclase feldspar is the major discrete mineral constituent and quartz approximates either hornblende or mica contents. Epidote, garnet, and magnetite or ilmenite are the prominent accessory minerals.

c. Deleterious Constituents: Alkali-reactive constituents were not observed in sand and gravel materials of the five test pit samples. The trace to one percent amounts of basalt in samples show the effects of granite assimilation and their contribution to alkali-reactivity is considered nil. Pyrite was observed in a few of the vein stone and epidosite granite materials but forms only trace amounts of test pit samples.

3. Physical Quality

a. Gravels: Except for the gravels from TP-33 of Crater Creek, test pit gravel materials are slightly to moderately weathered and stained, contain less than 10% of moderately well weathered stones, and have only trace to three percent amounts of soft particles (see tabulation I). Approximately one-third of TP-33 3/4"-#4 gravel material consists of stones that are pronouncedly stained with iron oxides and of reddish brown color. The iron oxide stain material is in the form of coatings at particle exteriors and occurs as thin films of tightly adhering material that usually covers more than 50% of a stones surface. Interiors of iron oxide coated or stained particles are generally only slightly to moderately altered. The iron oxide stains or coatings were usually not found to be soft to the brass rod scratch test, CRD-C-130. Soft particles in all gravel samples are largely friable stones that are sufficiently weathered so that grain bond is lost and granulation occurs. Granite stones in samples with progressive weathering tend to form granulated friable grain surfaces before altering to soft clay materials. Occasional soft stones that could be scratched by a brass rod were observed in samples but these were usually vuggy vein type materials. A few of the schistose biotite-hornblende stones broke along the foliation when weathered; however, during hammering of these stones most of the particles cleaved across the foliation and degree of weathering rather than rock type tends to govern the physical quality of these materials. Closely foliated and easily cleaved or splittable strongly micaceous schists were not observed in samples submitted.

PETROGRAPHIC REPORT (CONTINUED)	DATE AUG 19 1965	EXPL NO	SAMPLE NO Test Pits 33, 34, 58, 63 & 64
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Total undesirable particles - i.e., soft, friable, crumbly, fractured and cleavable stones - amount to less than 10% of gravel samples. Fractured and crumbly stones are particles having planes of weakness of such extent that these particles break or disintegrate when hit a few light blows with a 100 gram tack hammer. Stones with fractures or joints that are not easily cleaved are thus not included within this category. Most of the fractured and crumbly stones were found in the moderately well weathered materials. Particle shapes become more angular with decreasing screen size and are rounded to subrounded for plus 1/2" materials and prevailing subrounded to subangular for materials passing this screen. Particle surfaces average moderately rough for all test pit materials with most of the granite stones having pitted exteriors. Thin and elongate particles range from one to three percent of test pit samples. The gravels examined are from small sack samples and are thus only indicators of the quantity and types of particles present in test pit sources. However, physical quality comparisons of samples submitted would indicate the following: (1) Long Lake TP-64 gravels are of better physical quality than materials from other sources; (2) Crater Creek TP-33 gravels are inferior in physical quality to other materials; (3) gravels of Crater Creek TP-34 and Glacier Creek TP-58 are similar in quality and about average for materials submitted; and (4) gravels from the Glacier Creek TP-63 source are closest to Long Lake gravels in physical quality. Based upon samples submitted, over-all view is that Crater Creek gravels are inferior to gravels from other sources.

b. Sands: All test pit sand samples are slightly to moderately weathered and contain less than 6% of weathered grains by particle count (see tabulation II). Soft constituents as determined by the Red Devil Shaker test amount to 2.4% of TP-33, 3.6% of TP-34, 2.8% of TP-58 and 1.8% of TP-63 sand materials. Insufficient sample was present for performance of shaker test on Long Lake TP-64 sand; however, judging from the quantity of weathered grains counted in this sample, amounts of soft constituents present would probably be similar to those found in TP-63 Glacier Creek sand. In comparison, a rod-mill sand made from granite ledge rock at Long Lake Damsite contained 3% soft constituents and most of the sands used in major NPD concrete structures have had less than 6% of soft constituents. Both discrete mica flakes and soft constituents are most abundant in Crater Creek TP-34 sand. Particle shapes are subangular to subrounded for material retained on the No. 30 sieve and subangular to angular for material passing this sieve. Particle sufaces are rough. Mica flakes constitute the majority of thin and elongate particles.

Nelson B. Higgs

NELSON B. HIGGS
Chief, Petrography Branch

NPDEN-GS-L
TABULATION I

PERCENT BY SCREEN FRACTION OF CONSTITUENTS IN NA
FROM TEST PITS OF GLACIER CREEK, CRATER CREEK AND LONG LAKE SOU

Screen Size	Quartz-Feldspar	Light Colored Speckled Granite, Less Than 30% Dark Minerals	Dark-Colored Biotite-Hornblende Rock, More Than 30% Dark Minerals	Misc-ellaneous	Basalt	Megascopically Foliated, Gneissoid-Schistose Rock	Slightly Weathered and Stained
Glacier Creek TP 58							
1½"-3/4"	7	46	37	9	1	47	36
3/4"-½"	5	60	28	6	1	32	16
½"-3/8"	10	57	29	4	Trace	20	19
3/8"-#4	18	56	21	4	1	15	9
Arith. Average	10	54	29	6	1	29	20
Glacier Creek TP 63							
1½"-3/4"	10	59	24	7		19	46
3/4"-½"	11	61	16	12		16	48
½"-3/8"	10	62	18	9	1	16	40
3/8"-#4	12	68	14	6	Trace	11	26
Arith. Average	11	63	18	8	Trace	16	40
Crater Creek TP 34							
3/4"-½"	10	47	41	1	1	34	18
½"-3/8"	10	46	41	2	1	34	10
3/8"-#4	10	56	30	3	1	17	5
Arith. Average	10	50	37	2	1	28	11
Crater Creek TP 33							
3/4"-½"	8	66	19	4	3	26	18
½"-3/8"	6	82	10	1	1	10	12
3/8"-#4	6	82	10	1	1	8	8
Arith. Average	7	77	13	2	1	15	13
Long Lake TP 64 (LL TP 14)							
1½"-3/4"	5	86	2	7	-	6	85
3/4"-½"	5	85	6	4	-	8	82
½"-3/8"	1	85	11	3	-	9	89
3/8"-#4	3	89	5	3		4	80
Arith. Average	4	86	6	4		7	84

(1) Soft particle test, CRD-C-130, does not require testing of 3/8"-#4 material.
(2) Data is total weight of as-received material. Sizes footnoted contained less than 300 particles and in
and note thereto on page 10 of test method.
(3) Percentages of soft and friable particles in adjacent column are included in constituents of this fract
physically undesireable particles in samples.

TURAL GRAVELS

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Moderately Weathered and Stained	Moderately Well Weathered and Stained	Flat & Elong	Soft & Friable, CRD-130	Soft, Cleavable Fractured & Crumbly(3)	Weight Tested, Grams
61	3	1	3	7	2,828 (2)
74	10	1	3	8	1,308 (2)
69	12	2	4	7	1,085
80	11	4	(1)	(1)	337
71	9	2	3	7	
47	7	1	4	6	2,762 (2)
48	4	Trace	2	4	1,243 (2)
54	6	1	3	5	1,023
68	6	2	(1)	(1)	297
54	6	1	3	5	
75	7	4	3	6	1,015 (2)
84	6	4	3	9	743
90	5	2	(1)	(1)	252
83	6	3	3	7	
52	30	1	2	6	517 (2)
50	38	1	4	7	552 (2)
68	24	3	(1)	(1)	265
57	31	2	3	6	
15	-	-	-	-	1,995 (2)
17	1	-	1	1	749 (2)
10	1	2	-	2	341 (2)
18	2	1	(1)	(1)	314
15	1	1	Trace	1	

nsufficient weights of material by CRD-C-127, paragraph 4 (a)

tion. Except for iron oxide stained stones, represents total

2

NPDEN-GS-L
TABULATION II

WEIGHTED AVERAGE PERCENTAGE BY COUNT OF CONSTITUENTS IN NA
FROM TEST PITS OF GLACIER CREEK, CRATER CREEK AND LONG LAKE SOURCES

Screen Size	Quartz-Feldspar and Discrete Minerals Other Than Mica	Light-Colored Speckled Granite, Less Than 30% Dark Minerals	Dark-Colored Biotite-Hornblende Rock, More than 30% Dark Minerals	Miscellaneous
Glacier Creek TP 58				
Plus #8	2.7	8.6	3.2	0.5
#8-#16	5.6	8.0	1.9	0.5
16-30	12.4	9.1	1.0	0.5
30-50	15.9	6.2	0.5	-
50-100	13.1	0.8	-	-
Pan	4.1	-	-	
Total:	53.8	32.7	6.6	1.5
Glacier Creek TP 63				
Plus #8	2.1	9.6	1.8	1.5
#8-#16	6.3	7.6	1.3	0.8
16-30	16.3	5.8	0.7	0.4
30-50	19.3	2.8	0.2	
50-100	13.0	1.1	-	
Pan	4.3	-	-	
Total:	61.3	26.9	4.0	2.7
Crater Creek TP 34				
Plus #8	2.2	8.4	3.9	0.5
#8-#16	4.8	8.0	2.6	0.5
16-30	10.6	11.0	1.4	-
30-50	14.4	6.2	0.7	-
50-100	12.8	0.6	-	-
Pan	4.1	-	-	-
Total:	48.9	34.2	8.6	1.0

NATURAL SANDS

ES, SNETTISHAM PROJECT

Discrete Mica Flakes	Moderately Well Weathered and Stained	Percent * Retained
-	0.8	15
-	0.8	16
1.0	1.2	24
1.4	1.0	24
2.1	0.5	16
0.9	0.2	5
5.4	4.5	100%
-	0.6	15
-	0.6	16
0.8	1.0	24
1.7	0.8	24
1.9	0.5	16
0.7	0.1	5
5.1	3.6	100%
-	1.1	15
0.1	0.8	16
1.0	1.4	24
2.7	1.2	24
2.6	0.8	16
0.9	0.2	5
7.3	5.5	100%

NPDEN-GS-L
TABULATION II - Continued

WEIGHTED AVERAGE PERCENTAGE BY COUNT OF CONSTITUENTS IN
FROM TEST PITS OF GLACIER CREEK, CRATER CREEK AND LONG LAKE SOUR

Screen Size	Quartz-Feldspar and Discrete Minerals Other Than Mica	Light-Colored Speckled Granite, Less Than 30% Dark Minerals	Dark-Colored Biotite-Hornblende Rock, More Than 30% Dark Minerals	Miscellaneous
Crater Creek TP 33				
Plus #8	3.0	10.2	1.4	0.4
#8-#16	5.1	9.0	1.6	0.3
16-30	14.2	8.4	1.0	0.2
30-50	15.4	7.2	0.2	Trace
50-100	12.2	1.3	0.4	-
Pan	4.4	-	-	
Total:	54.3	36.1	4.6	0.9
Long Lake TP 64 (LL TP-14)				
Plus #8	1.2	12.5	0.9	0.4
#8-#16	5.6	9.0	1.1	0.3
16-30	15.1	7.4	0.7	0.5
30-50	20.9	1.9	-	-
50-100	14.1	0.3	-	-
Pan	4.5	-	-	-
Total:	61.4	31.1	2.7	1.2

* Percent retained data used in computing weighted percentages are from near midpoint of perce
civil works sand gradation specification and at FM 2.77.

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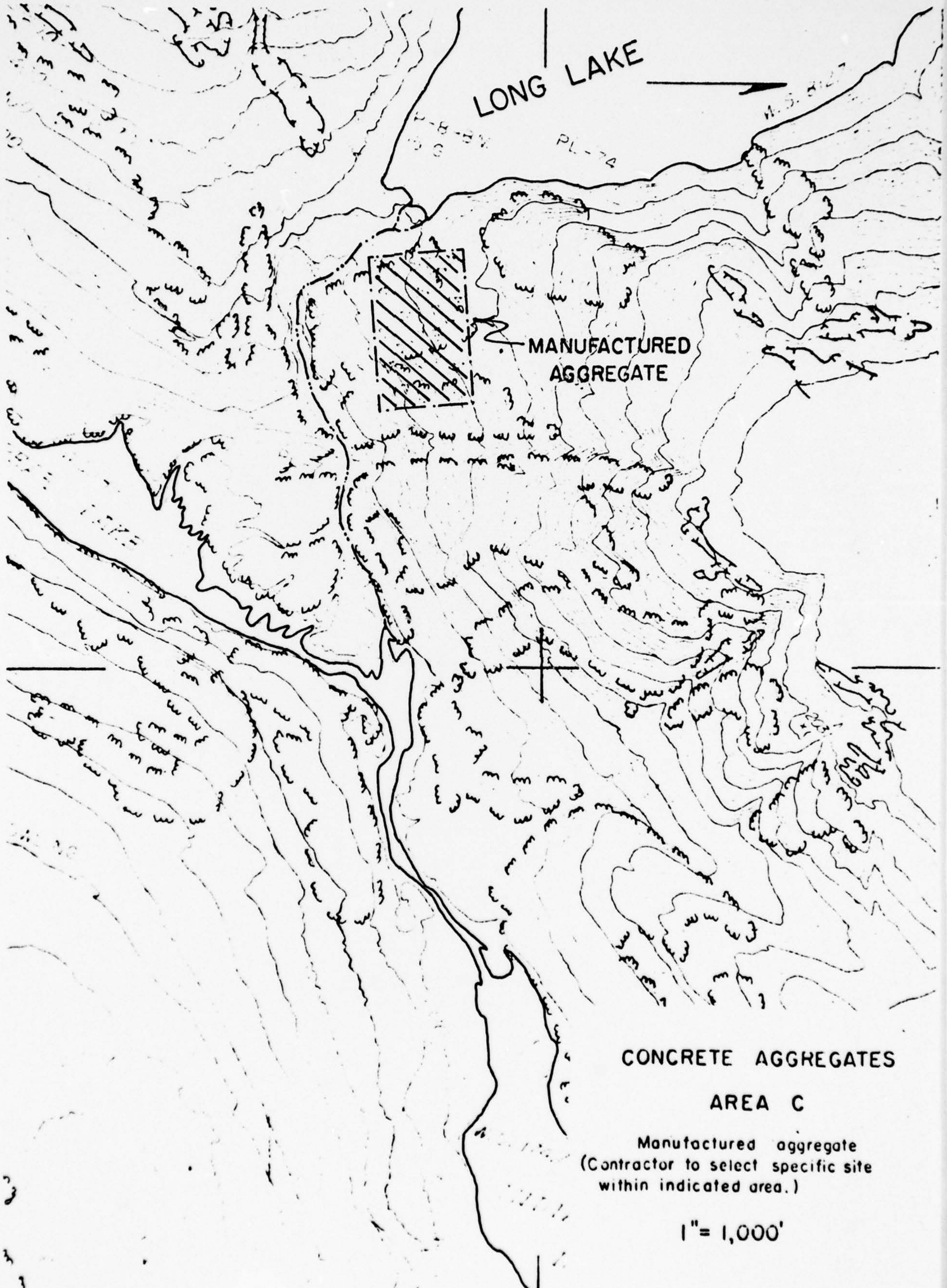
NATURAL SANDS

ES, SNETTISHAM PROJECT

Discrete Mica Flakes	Moderately Well Weathered and Stained	Percent * Retained
-	1.5	15
-	1.1	16
0.2	1.2	24
1.2	1.0	24
2.1	0.5	16
0.6	0.1	5
4.1	5.4	100%
-	0.4	15
-	0.5	16
0.3	0.5	24
1.2	0.5	24
1.6	0.3	16
0.5	0.2	5
3.6	2.4	100%

nt retained range for each screen size given in standard

PART 4 CONCRETE AGGREGATE - TRIAL MIX - C



CONCRETE AGGREGATES

AREA C

Manufactured aggregate
(Contractor to select specific site within indicated area.)

1" = 1,000'

CORPS OF ENGINEERS, U.S. ARMY OFFICE OF THE DIVISION ENGINEER NORTH PACIFIC DIVISION 500 PITTOCK BLOCK PORTLAND 5, OREGON NPD TESTING LABORATORY	PETROGRAPHIC REPORT		
	DATE 30 Apr 65	EXPL. NO	SAMPLE NO. NPD Lab No. 12937
	PETROGRAPHER N. B. Higgs		W/O NO 64-CP-188

SAMPLED BY	PROJECT	SOURCE
District Personnel	Long Lake Damsite, Snettisham Project, Juneau, Alaska	Surface Exploratory Quarry, Long Lake Damsite
SUBMITTED BY (DIST OR AGENCY) Alaska District		

1. Samples and Tests

Approximately 3600 pounds (six barrels) of blasted ledge rock from the above source was submitted for processing into nominal sizes of coarse aggregate and rod-mill sand for various elementary tests, freeze-thaw soundness, petrographic examination to include a study of mica in the rod-mill sand and mortar tests for evaluation of the influence of mica on compressive strength. Selected NX core samples of similar gneissoid quartz diorite rock from the island and right abutment sources were previously examined and the results are detailed in Petrographic Report dated 12 November 1964. Although of somewhat different origin, the gneissoid quartz diorite from Long Lake has a remarkable resemblance both in texture and in composition to the quartz diorite gneiss or granite gneiss rock found in the vicinity of Dworshak Dam (N. Fork Clearwater River) Idaho. The gneiss rock at Dworshak has been extensively investigated for use as concrete aggregate and, for comparison purposes, inclosed are two WES Forms 726 from TM 6-370 containing test data relative to the Dworshak aggregates. The Long Lake aggregates were examined by CRD C-119 and CRD C-120, respective tests for flat and elongate particles in coarse and fine aggregate. Test procedures used in studies of mica in the rod-mill sand are given below in paragraphs pertinent thereto. Attached are: (1) Table I giving weighted average percent constituents in fine and coarse aggregate and (2) Table II containing results of mica studies. Also inclosed are two photographs showing sink-float separates and blends of high and low mica sands used for mortar strength studies.

2. Composition and Mica Study

Except for about 27% discrete-quartz-feldspar particles, the coarse aggregate material consists predominantly of medium grained gneissoid quartz diorite or a granite rock having a foliated structure and having characteristics similar to those described in the petrographic examination of previously submitted NX core samples. That is, the major rock type present is gneissoid quartz diorite having a slightly to well foliated structure with randomly alternating, subparallel, light and dark colored bands or lenticles containing varying proportions of quartz, feldspar, hornblende and biotite mica minerals (see photograph to previous report). The white or light-colored bands, patches or lenticles in the quartz diorite consist essentially of equidimensional quartz and feldspar with minor biotite-hornblende dark minerals; whereas, the darker colored of speckled bands have greater amounts of hornblende and biotite in reduced amounts of light-colored quartz and feldspar. The bulk sample differs in composition from previously examined NX core materials in the following ways. (1) The bulk sample contains greater amounts of quartz-feldspar rock in the form of fine-grained aplitic material derived from large thick quartz-feldspar folia in the quartz diorite and from

Incl. 2

PETROGRAPHIC REPORT (CONTINUED)	DATE 30 Apr 65	EXPL. NO.	SAMPLE NO. NPD Lab No. 12937
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aplite dikes such as were observed cutting the foliation in plus 3" hand samples; (2) Dark-colored rock facies, fine grained hornblende granulite and gneissoid coarse grained biotite-hornblende rock, observed as samples in the NX core material were not recognized as discrete particles in the bulk material. A few small xenoliths or inclusions of the dark granulite facies were observed in some of the larger chunks, however. Previous thin section studies of the NX core samples indicated that the quartz diorite contains an estimated average of 18% dark minerals (13% biotite mica, 5% hornblende); 79% light-colored minerals (60% plagioclase feldspar, 15% quartz, 4% orthoclase feldspar); and 3% miscellaneous accessory minerals. Quartz feldspar folia or the white bands in the NX core samples contained from five to ten percent dark minerals consisting largely of biotite with only minor hornblende. Mineral composition of the bulk aggregate sample as obtained from particle counts of the rod-mill sand is shown in Table I. The fine aggregate, by particle count, contains weighted average percentages of about 56% discrete and rock particle light-colored quartz-feldspar minerals, 28% quartz-feldspar rock particles with minor dark minerals, 2% dark biotite-hornblende rock particles with minor light felsic minerals, 3% discrete dark prismatic hornblende, and 11% discrete dark biotite mica flakes. Total mica-hornblende content, using average estimates of these minerals in the dark rock particles and in the speckled dark quartz-feldspar rock particles, is between 16 and 18 percent or slightly less than the amounts of these minerals found by thin section studies of the NX core samples. Under heading No. 1 of Table II are given the weighted average percent of biotite-hornblende minerals that were removed on a weight basis by 2.86 bromoform sink-float separations performed on 24,000 grams of representative material screened in a Ty-Lab shaker to provide the amounts per screen fraction shown. The total weighted average percent of biotite-hornblende sinks is 10.8% and is less than the amounts found by grain counts for two reasons: (1) The bromoform separates are on a weight basis, whereas, the particle counts are on a volume basis; (2) Sink-float specific gravity separations do not completely separate heavier biotite and hornblende particles from lighter quartz and feldspar particles because minor amounts of biotite and hornblende are entrapped in the float quartz-feldspar particles. Most of the discrete biotite and hornblende grains, either by weight or by volume, are found in the minus No. 16 sieve material where rock grains are sufficiently divided so as to release mineral constituents. The sink-float separates on the rod-mill sand are, therefore, indicative of total amounts of discrete biotite-hornblende plus heavy biotite-hornblende rock particles rather than total amount of biotite and hornblende present. Data under heading No. 5 contains the results of sink-float separates made on material in which the No. 8, No. 16, No. 30 and No. 50 sieve fractions were ground to a fine powder so as to release entrapped biotite and hornblende heavy minerals. This resulted in an increase in the percent sinks per these sieve sizes and a total increase in weighted average percent sinks from 10.8% to 13.8%. Thus, total amounts of biotite and hornblende are between 16%-18% by volume grain counts and about 14% by sink float separates of finely ground material. Grain counts were also made of the heavy separates from the original rod-mill sand and the results are contained under heading No. 6 of Table II. The sinks, using combined weight and volume count parameters, contain 17% discrete hornblende, 62% discrete biotite, 18% mixed biotite-hornblende dark particles and 3% of accessory heavies consisting largely of epidote with minor amounts of zircon, apatite, sphene, and opaques. Recalculating these percentages so as to exclude accessories

along with estimates of percent biotite and hornblende in dark rock particles give a total composition of about 22% hornblende and 78% biotite. Using these percentages of hornblende to biotite, the original rod-mill sand without subsequent grinding contains 2.4% hornblende and 8.4% biotite on a weight basis; while the rod-mill sand after grinding to release particles in the plus No. 50 sieve fractions contains 3% hornblende and 10.8% biotite on a weight basis. The above data is recapitulated as follows:

Weighted average % sinks on weight basis in natural rod-mill sand.	10.8%		
Hornblende		2.4%	
Biotite		8.4%	
Weighted average % sinks on weight basis in rod-mill sand with plus No. 50 material reground	13.8%		
Hornblende		3.0%	
Biotite		10.8%	
Total biotite-hornblende in original rod-mill sand by grain count.	16-18%		
Discrete hornblende		3.0%	
Discrete biotite		11.0%	
Total discrete biotite-hornblende			14.0%

3. Mortar Strengths

Biotite mica is a mineral that can be flaked along numerous potential cleavage planes of weakness to thinner subdivided particles having flat shapes. The amount of discrete mica flakes formed is dependent upon interlock of this mineral in the rock mass and the type of processing used to make aggregate from rock containing this mineral. The manner of occurrence of this mineral in aggregates is the significant feature; that is, the number of discrete mica flakes present in the sand rather than mica held in aggregate particles has the greatest influence relative to mortar strengths. In the rod-mill sand made in this laboratory, most of the discrete mica flakes occur in the material passing the No. 16 sieve and comprise about 11% of sample by count. Because of the occurrence of this potentially weak mineral in the Long Lake aggregate three series of three mortar cubes containing sands with natural, high, and low mica contents were made from the sink-float separate fractions in amounts shown under heading No. 1, 2, and 3 of Table II. The high mica content cubes contain blended sand with 48.2% sinks and about 30% discrete biotite. Low mica cubes contain 100% floats, no sinks, and have only minor traces of discrete biotite. Results of the mortar strength tests are shown under heading No. 4 of Table II and indicate the following: (1) Mortar strengths for all combinations of mica are greater than with standard Ottawa sand. (2) Mortar strengths of cubes containing low mica content sand are

greater than those with either natural or high mica contents, showing that mica does influence mortar strengths. (3) Both the natural and high mica content mortar cubes have essentially the same strengths indicating that discrete mica at the 11% level has as much effect on mortar strength as at the 30% level.

4. Physical Properties

The coarse aggregate ranks as moderately weathered and contains about 52% slightly weathered and stained particles, 46% moderately weathered and stained particles and about 2% moderately well weathered and heavily iron oxide stained particles. Examination of rock chunks prior to crushing indicated that most of the alteration present is attributable to weathering along joints with interior of chunks being only slightly altered. Soft particles that can be scratched with a brass rod by CRD C-130 were not observed. Thin and elongate particles are minor and amount to about two percent of coarse aggregate sample. However, particles with significant open megafractures are present in the larger sized particles and comprise about 21% of the 6"-3" material and about 13% of the 3"-1½" material. The 1½"-3/4" and 3/4"-#4 nominal sizes contained only a few particles having fractures of this type. Soft and attritionable constituents in the rod-mill sand amount to about 3% by the Red Devil Shaker test and from examination of the wash water consist largely of a slurry of minute mica flakes. Particle counts of the No. 100 sieve material after shaking showed about 23% discrete mica flakes, or an increase of about 4% in the amounts found in this sieve size prior to shaking. Flat and elongate particles amount to about 9% of the rod-mill sand. These particles consist largely of discrete mica flakes in the minus No. 16 sieve material and about equal proportions of feldspar fragments and mica flakes in material retained on this sieve. Alkali-reactive constituents were not observed in sample. Small crystals of pyrite were observed in a few of the coarse aggregate particles, but form only trace amounts in sample. Physical properties of the foliated granite rock from Long Lake are largely determined by textures and structures. Specifically, two items warrant attention: (1) Possible splitting of rock along foliation planes and (2) granulation because of poor interlock between constituents and/or the presence of cleavable feldspar, biotite and hornblende minerals. In the sample examined, splitting along foliation planes does not appear to be a problem because flat particles are minor and less than one-quarter of the fractured particles in the larger coarse aggregate sizes had fractured parallel to the foliation. Granulation of this material during processing and subsequent mixing may be a problem, however. The Los Angeles abrasion test loss after 500 revolutions at A grading is 52%. Granite rocks are known to be subject to granulation and the following quote from Blanks and Kennedy in The Technology of Cement and Concrete (p. 285) illustrates the problem: "Highly siliceous igneous rock such as granite, crystallized progressively, so that the last-formed mineral (usually quartz) is molded against the relatively smooth surfaces of the early formed crystals. Consequently, the texture is poorly interlocked and granulation occurs easily, the low strength being most evident in particles comprising relatively few crystals . . . ". Mixer grinding studies should show whether granulation is a problem with the Long Lake granite rock. As noted in the prior petrographic report, mixer grinding studies of

PETROGRAPHIC REPORT (CONTINUED)	DATE 30 Apr 65	EXPL. NO.	SAMPLE NO. NPD Lab No. 12937
	PETROGRAPHER N. B. Higgs		W/O NO. 64-CP-188

coarse to medium grained granite gneiss aggregate from Dworshak Dam have shown significant changes in fineness modulus of charged aggregates before and after mixing. For example, the reduction in fineness modulus of Dworshak granite gneiss fine aggregate based upon nine mixer grinding tests ranged from 7.2 to 27.8%, the average being 15.9%. Maximum Los Angeles abrasion loss found for tests on the Dworshak coarse aggregate was about 39% as compared to 52% for the present sample of Long Lake granite.

Nelson B. Higgs
NELSON B. HIGGS
Chief, Petrography Branch

NPDEN-GS-L (64-CPCh-188)
SNETTISHAM PROJECT

TABLE I

WEIGHTED AVERAGE PERCENT CONSTITUENTS IN FINE AND

	Coarse Aggregate[3]					
Screen Size	Gneissoid Quartz Diorite	Quartz-Feldspar Rock	Slightly Weathered & Stained	Moderately Weathered & Stained	Moderately Well Weath. & Stained	F Tabul Fro 3:1 Th
6"-3" Nom. Size	64	36	41	56	3	
Total[1]	14.5	8.2	9.3	12.7	0.7	
3"-1½" Nom. Size	77	23	41	57	2	1
Total[1]	17.6	5.3	9.4	13.1	0.4	
1½"-3/4" Nom. Size						
1½"-1"	33.9	12.1	24.1	21.3	0.6	
1"-3/4"	35.0	13.0	25.7	21.5	0.8	
Minus 3/4"	4.5	1.5	3.2	2.7	0.1	
Subtotal[1]	73.4	26.6	53.0	45.5	1.5	
Total[1]	11.2	4.0	8.1	6.9	0.2	
3/4"-#4 Nom. Size						
Plus 1/2"	17.4	6.6	14.9	8.5	0.6	
1/2"-3/8"	16.1	4.9	13.9	6.9	0.2	
Minus 3/8"	42.3	12.7	36.4	18.1	0.5	
Subtotal[1]	75.8	24.2	65.2	33.5	1.3	1
Total[1]	29.7	9.5	25.6	13.1	0.5	
Grand Total[1]	73.0	27.0	52.4	45.8	1.8	1

Fine Aggregate

Sieve Size	Light Colored Qtz-Feld. Minerals and Rock Particles: % of Sieve	Light Colored Qtz-Feld. Minerals and Rock Particles: Wt.Avg. %	Qtz-Feld. Rock Particles with Minor Dark Minerals: % of Sieve	Qtz-Feld. Rock Particles with Minor Dark Minerals: Wt.Avg. %	Dark Biot-Horn. Rock Particles with with Minor Light Colored Minerals: % of Sieve	Dark Biot-Horn. Rock Particles with with Minor Light Colored Minerals: Wt.Avg. %	Discrete Hornblende: % of Sieve	Discrete Hornblende: Wt.Avg. %	Discret: % of Sieve
#4-#8	27.2	2.2	71.6	5.7	1.2	0.1	-		-
8-16	34.0	6.1	63.2	2.4	2.4	0.5	0.2	trace	0.2
16-30	59.2	16.0	33.2	9.0	2.0	0.5	0.4	0.1	5.2
30-50	64.2	14.7	9.5	2.2	3.0	0.7	4.8	1.1	18.5
50-100	70.3	10.5	2.0	0.3	-		8.0	1.2	19.7
Pan	68.7	6.2	0.6	trace	1.7	0.2	6.3	0.6	22.7
Total		55.7		28.6		2.0		3.0	

1/Subtotals give weighted average percent of constituents per nominal size. Amounts under total are weigh sizes recalculated to omit sand fraction. Grand total figures give weighted average percent of constitu

2/Flat and elongate particles consist of about 50% feldspar on No. 8 and 16 sieves, 74% biotite mica on N

3/Percent of constituents is by weight for coarse aggregate and by count for fine aggregate.

30 April 1965

OARSE AGGREGATE

rticle Shapes - CRD C-119

r & Wedge 2:1 to Width to ckness	Flat & Elongate Width to Thickness & Length to Width Ratio > 3:1	Fractured Parallel Foliation	Total	% Ret. in Nom. Size	% Nom. Size Retained in Sample
0	4	5	21		
4.5	0.9				22.7
5	2	3	13		
3.4	0.5				22.9
2.6	0.2			46	
4.8	0.3			48	
0.6	trace			6	
8.0	0.5			100.0	
1.2	0.1				15.2
4.6	0.1			24	
1.9	0.4			21	
5.0	1.1			55	
1.5	1.6			100.0	
4.5	0.6				39.2
3.6	2.1				100.0

Biotite Mica Wt.Avg. %	Flat & Elongate[2/] CRD C-120 % of Sieve	Wt.Avg. %	Percent Retained	Grains Counted
	2.8	0.2	8	500
trace	1.6	0.3	18	500
1.4	5.4	1.5	27	500
4.3	11.8	2.7	23	400
3.0	15.7	2.4	15	300
2.0	22.7	2.0	9	300
10.7		9.1	100.0	

ted average percent constituents of this nominal size using percent of nominal
nts in coarse aggregate and is a summation of the total figures per nominal size.
. 30 Sieve, and greater than 90% biotite mica on remaining sieves.

2

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Snattisham Project

TABLE II

MICA STUDY-MORTAR MAKING PROPERTIES WITH DI

1

Percent of Sink-Floats in Original Rod-Milled Sand

Sieve Size	Total Weight Grams	Weight Floats Grams	Weight Sinks Grams	% Floats	% Sinks	% Retained	Wt.Avg. % Sinks	% Sinks Using Wt. of Sink-Float Sample
#4-#8	3600	3547	53	98.5	1.5	8	0.1	0.2
8-16	4800	4644	156	96.7	3.3	18	0.6	0.6
16-30	4800	4503	297	93.8	6.2	27	1.7	1.2
30-50	5760	4814	946	83.6	16.4	23	3.8	3.9
50-100	3360	2756	604	82.0	18.0	15	2.7	2.5
Pan	1680	1330	350	79.2	20.8	9	1.9	1.5
Totals	24000	21694	2406				10.8	9.9

3

Proportions of Low Mica Mortar Cubes - No Sinks & 100% Floats

Sieve Size	Total Grams Required	% Floats	% Sinks	Grams Floats	Grams Sinks
#4-#8	450	100	Zero	450	Zero
8-16	600	"	"	600	"
16-30	600	"	"	600	"
30-50	720	"	"	720	"
50-100	420	"	"	420	"
Pan	210	"	"	210	"
Totals	3000	100.0	Zero	3000	Zero

5

Percent of Sinks in Natural Sand After Sink-Float Separations of No. 8 thru No. 50 Sizes Ground to Powder

Sieve Size	% Sinks	% Retained	Wt.Avg. % Sinks
#4-#8	8.2	8	0.7
8-16	8.4	18	1.5
16-30	11.1	27	3.0
30-50	17.2	23	4.0
50-100	18.0	15	2.7
Pan	20.8	9	1.9
Totals		100.0	13.8

30 April 1965

FFERENT PROPORTIONS OF MICA

2

Proportions of Sink-Floats in High Mica Mortar Cubes
.2% sinks or 4.8 times amount of sinks per sieve size of original rod-mill sand)

ieve ze	Total Grams Required	% Floats	% Sinks	Grams Floats	Grams Sinks	Percent Sinks in Total Sample per Screen Fraction
#8	450	92.8	7.2	417.6	32.4	1.1
16	600	84.2	15.8	505.2	94.8	3.2
30	600	70.3	29.7	421.8	178.2	5.9
50	720	21.3	78.7	153.4	566.6	18.9
100	420	13.6	86.4	57.1	362.9	12.1
	210	0.2	99.8	0.0	210.0	7.0
als	3000					48.2

4

ar Strengths: Standard Ottawa-Natural, Heavy and Low Mica Snettisham Rod-Mill Sand

	Standard Ottawa 7-Day	Standard Ottawa 28-Day	1 Natural Rod-Mill 7-Day	1 Natural Rod-Mill 28-Day	2 High Mica 7-Day	2 High Mica 28-Day	3 Low Mica 7-Day	3 Low Mica 28-Day
. Compressive Strength	1540	2950	1740	3240	1775	2985	2220	3800
ent of Standard	100	100	113	110	115	101	144	129

6

Weighted Average Percent Constituents in Sink Separates Natural/Sand Rod-Mill

ve	% Discrete Hornblende % F	% Discrete Hornblende Wt.%	% Discrete Biotite % F	% Discrete Biotite Wt.%	Mixed Dark Particles % F	Mixed Dark Particles Wt.%	Epidote and Other % F	Epidote and Other Wt.%	Wt.Avg. % Sinks Retained
#8	4.0		6.0		85.0	0.1	5.0		0.1
16	5.9		8.0		81.3	0.6	4.7		0.6
30	10.7	0.2	51.3	0.9	36.3	0.6	1.7		1.7
50	19.0	0.8	69.0	2.6	11.3	0.4	0.7		3.8
100	16.0	0.5	75.0	2.0	4.0	0.1	5.0	0.1	2.7
	18.0	0.4	67.0	1.2	6.0	0.1	9.0	0.2	1.9
als		1.9		6.7		1.9		0.3	10.8
Total Wt.Avg.		17%		62%		18%		3%	

CORPS OF ENGINEERS, U S ARMY
OFFICE OF THE DIVISION ENGINEER
NORTH PACIFIC DIVISION
500 PITTOCK BLOCK
PORTLAND 5, OREGON

NPD TESTING LABORATORY

PETROGRAPHIC REPORT

DATE 30 Apr 65	EXPL. NO. SAMPLE NO C-13002
PETROGRAPHER N. B. Higgs	W/O NO 64-CPCh-188
SAMPLED BY	PROJECT Snettisham Project Juneau, Alaska
SUBMITTED BY (DIST OR AGENCY) Alaska District	
SOURCE FREEZE-THAW BEAMS Prepared with Manufactured 3/4"-#4 Coarse Aggregate and Rod-Mill Sand from Granite Ledge Rock	

1. Samples and Tests

One series of freeze-thaw beams was prepared with laboratory manufactured 3/4"-#4 coarse aggregate and rod-mill sand made from gneissoid granite ledge rock obtained from the vicinity of Long Lake Damsite, Snettisham Project, Alaska. The series of beams was tested in accordance with test method CRD C-114. All beams contained 44% fine aggregate, had a water-cement ratio of 0.49, and were retained in the freeze-thaw unit for 300 cycles of alternate freezing and thawing. Other test data are as follows:

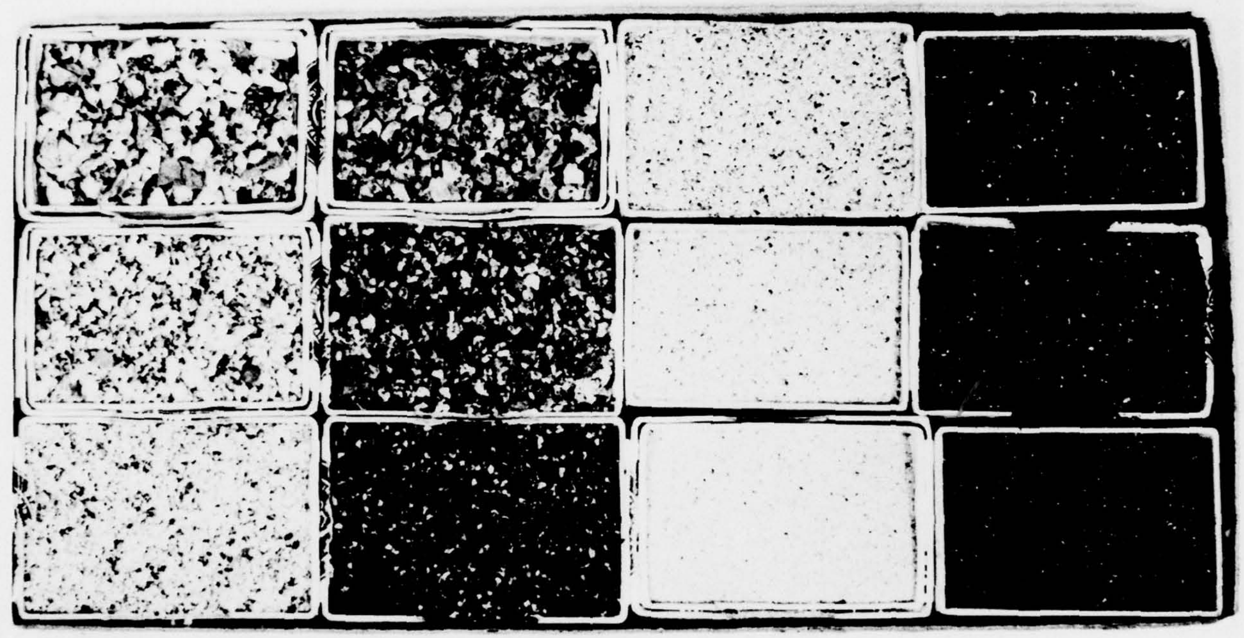
Series & Set No.	Slump, Inches	% Air	DFE_{300} Avg.	Beam Nos.	Rel. E of Each Beam at 300 Cycles
C-13002	2.00	6.2	70.2	1	72.3
				2	70.6
				3	67.7
C-13002A	2.25	6.0	66.1	4	65.9
				5	64.2
				6	68.2
C-13002B	2.25	6.4	65.7	7	64.5
				8	68.0
				9	64.5
Grand Average DFE_{300}			67.3		

2. Examination of Beams

All beams have well preserved original contours. Beams No. 5 and No. 6 have lost corners to respective depths of one-half and one inch, otherwise the beam surfaces show only minor mortar-coarse aggregate losses. Surface relief of projecting coarse aggregate particles averages less than one-sixteenth inch. The mortar is hard and firm. Surface coarse aggregate particles when pried with a dull dental probe tend to granulate rather than break from the mortar indicating that the mortar-coarse aggregate bond is good and greater than the abrasion resistance of the granite particles. Air voids are normal in sizes, amounts and distribution. There is no evidence of aggregate segregation, or bleeding. The moderate depths of penetration of destructive freeze-thaw action are illustrated by the dark wet edges of the sawed sections shown in the accompanying photograph. The slices were cut one-half inch thick from third points of selected beams, air dried, then placed in water one-fourth inch deep for 15 minutes to allow for capillary rise of moisture through ruptured peripheral mortar, and were then photographed immediately.

NPD FORM 306
22 MAR 49

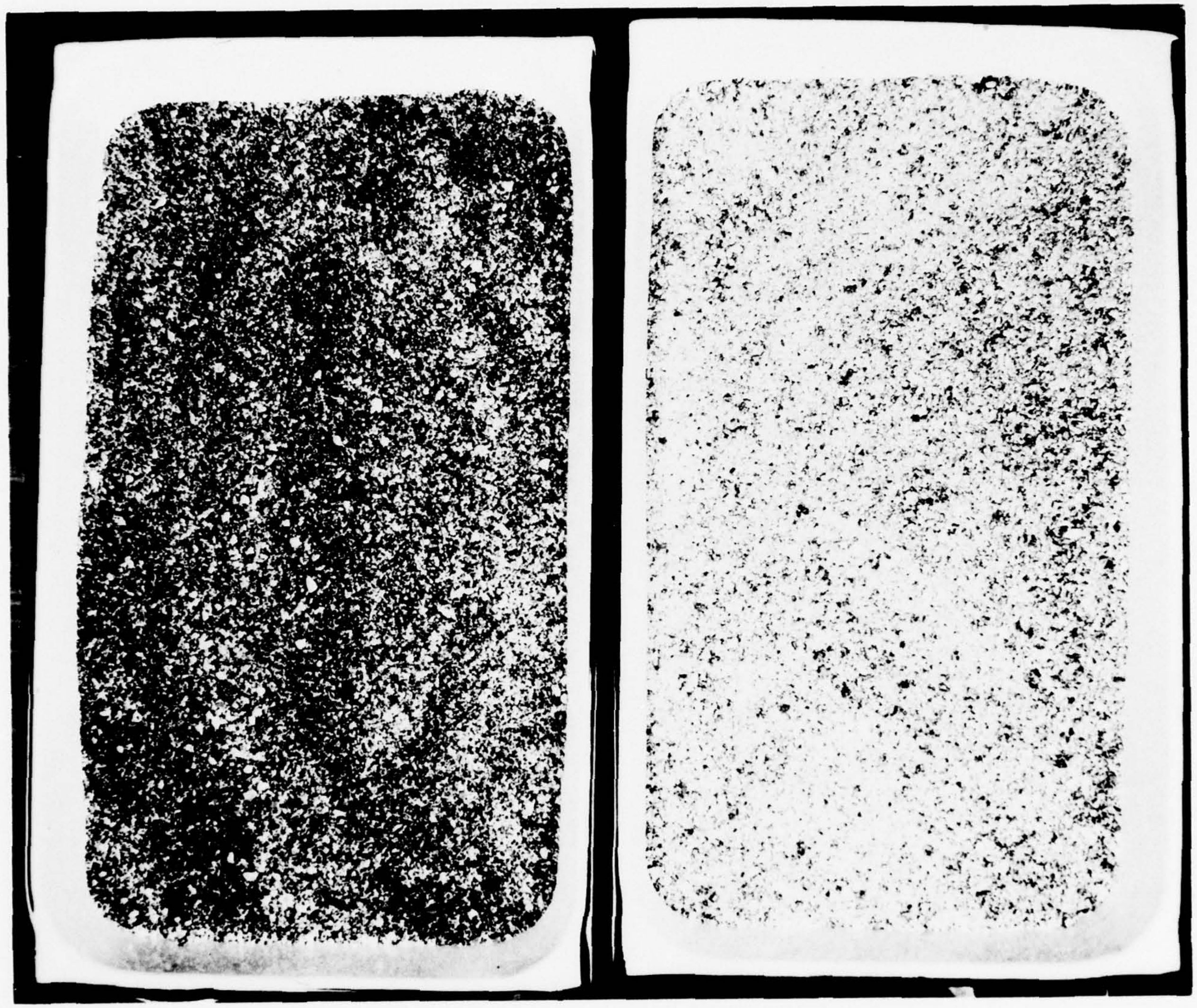
NELSON B. HIGGS
Chief, Petrography Branch



Snettisham Project

Samples of Dark Sink and Light Float Separates from
No.8, 16, 30, 50, 100 and Pan Sizes of Rod-Mill Sand.

30 Apr. 65



Snettisham Project 30 Apr 65

Left and Right, High and Low Mica Blended Rod-Mill Sands for Mortar Strength Studies.

Snettisham Project

Freeze-Thaw Beams Prepared with Manufactured Coarse Aggregate and Rod-Mill Sand Made from Granite Ledge Rock Bulk Sample.

30 Apr. 65

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SNETTISHAM PROJECT

30 April 1965

Aggregate Tests

	Nominal Size 6"-3"	3"-1½"	1½"-3/4"	3/4"-No.4	Sand
1. Specific Gravity (BSSD)	2.68	2.66	2.65	2.61	2.65
2. Absorption, %	0.6	0.7	0.4	1.4	0.5
3. Unit Weight lb/cu.ft.	93.9	94.7	92.0	90.3	102.0
4. Los Angeles Abrasion, (Grading "A")					
% wear @ 100 Rev.		13.1			
% wear @ 500 Rev.		51.6			
5. Percent Minus No. 200					0.6
6. Freeze-Thaw, DFE300 300 cycles					
Round 1					70.2
2					66.1
3					65.7
Average					67.3

7. Mortar Strength

	Ottawa Standard 7-Day	28-Day	Rodmill Sand 7-Day	28-Day	High Mica Content 7-Day	28-Day	Low Mica Content 7-Day	28-Day
a. Compressive								
(1) PSI	1525	3050	1860	2950	1810	3000	2475	3725
	1610	2750	1620	3600	1740	2925	2005	3600
	1490	3050	1745	3175	1770	3025	2185	4050
Avg.	1540	2950	1740	3240	1775	2985	2220	3800
(2) % of control	100	100	113	110	115	101	144	129
b. Flexural								
(1) PSI	505	755	325	610				
	470	830	360	650				
	430	-	360	705				
Avg.	470	795	350	655				
(2) % of control	100	100	74	82				

Incl 1

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29 January 1965

SNETTISHAM PROJECT

Processing Studies

1. Primary Crushing

a. Crusher: 15" X 24" jaw crusher

b. Setting: 6"

c. Feed: 1173 lb. of quarry run (large pieces only)

d. Product:

	+6"	6"-3"	3"-1½"	1½"-3/4"	3/4"-No.4	-No.4	Total
(1) Nominal Size	+6"	6"-3"	3"-1½"	1½"-3/4"	3/4"-No.4	-No.4	Total
(2) Weight, lb.	0	581*	421	74	65	32	1173
(3) Percent	0	49.6	35.9	6.3	5.5	2.7	100

*451 Lb. saved for aggregate stock.

2. Secondary Crushing

a. Crusher: 15" X 24" jaw crusher

b. Setting: 3"

c. Feed:

	Quarry Run	Primary	Total
Plus 6"	2344		2344
6"-3"		130	130
Total			2474

d. Product:

	+3"	3"-1½"	1½"-3/4"	3/4"-No.4	-No. 4	Total
(1) Nominal Size	+3"	3"-1½"	1½"-3/4"	3/4"-No.4	-No. 4	Total
(2) Weight, lb.	65	1338**	440	305	196	2344
(3) Percent	2.8	57.0	18.8	13.0	8.4	100

**455 lb. saved for aggregate stock.

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Snettisham Project Processing Studies (Cont'd)

29 January 1965

3. Tertiary Crushing

a. Crusher: 15" X 24" jaw crusher

b. Setting: 1½" Max.

c. Feed:

	Primary	Secondary	Total
Plus 3"		65	65
3"-1½"	421	883	1304
Total	421	948	1369

d. Product:

(1) Nominal Size:	+1½"	1½"-3/4"	3/4"-No.4	-No.4	Total
(2) Weight, lb.	160	720*	330	129	1339
(3) Percent	12.0	53.8	24.6	9.6	100

*300 lb. saved for aggregate stock.

4. Quarternary Crushing

a. Crusher: 18" gyratory

b. Setting: 3/4" Max.

c. Feed:

	Primary	Secondary	Tertiary	Total
3"-1½"			160	160
1½"-3/4"	74	440	420	934
Total	74	440	580	1094

d. Product:

(1) Nominal Size	3/4"-No.4	-No.4	Total
(2) Weight, lb.	780**	285	1065
(3) Percent	73.2	26.8	100

**780 lb. saved for aggregate stock.

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W. O. 64-CPCh-188
Snettisham Project Processing Studies (Cont'd)

29 January 1965

5. Sand Manufacture:

a. Mill: 16" X 32" rodmill
Rod charge 7 - 2-3/8" dia.
9 - 2" dia.
3 - 1-5/8" dia.
3 - 1-3/8" dia.

Charge weight 600 lb.

b. Classifier: Rake Type

c. Feed:

	Primary	Secondary	Tertiary	Quaternary	Total
3/4"-No.4	65	305	330	-	700
-No. 4	32	196	129	285	642
Total	97	501	459	285	1342

d. Rate of Feed: 1550 lb/hr.

e. Loss in Milling: 13.4 percent

f. Product:

(1) Weight: 1162 lb.

(2) Gradation

Size	Percent Passing Product	Percent Passing Specs1/	Ind. Percent Retained Product	Ind. Percent Retained Specs2/
3/8"		100		0
No. 4	100	95-100	0	0-5
No. 8	92	80-90	8	5-20
No. 16	74	55-75	18	10-22
No. 30	47	30-60	27	18-32
No. 50	24	12-30	23	18-32
No. 100	9	2-10	15	10-25
Pan			9	5-10
FM	2.54	2.4-3.1	2.54	2.25-2.85

1/ CE 1401.01, Alternate 1

2/ CE 1401.01, Alternate 2

NPDEN-GS-L 29 January 1965
W. O. 64-CPCh-188
Snettisham Project Processing Studies (Cont'd)

6. Summary of Aggregate Production

	6"-3"	3"-1½"	1½"-3/4"	3/4"-No.4	Sand
a. Weight produced, lb.	451	455	300	780	1162
b. Percent of Quarry Run:	13.2	13.3	8.8	22.8	34.0

Note: 10.5% (369#) loss in processing.

c. Gradations:

	Nominal Size											
	6"-3"		3"-1½"		1½"-3/4"		3/4"-No. 4		Sand			
Screen	Percent Passing										Ind. % Ret.	
Size	Prod.	Spec.	Prod.	Spec.	Prod.	Spec.	Prod.	Spec.	Prod.	Spec.	Prod.	Spec.
6"	100	90-100										
5"	89											
4"	62	20-45	100	100								
3"	7	0-15	95	90-100								
2½"			87									
2"			61	20-55		100						
1½"			24	0-10	100	90-100						
1"			4	0-5	54	20-45	100	100				
3/4"			3		6	0-10	96	90-100				
1/2"					3		76					
3/8"					2	0-5	55	30-55		100		
No. 4							11	0-5	100	95-100		0-5
No. 8									92	80-90	8	5-20
No. 16									74	55-75	18	10-22
No. 30									47	30-60	27	18-32
No. 50									24	12-30	23	18-32
No. 100									9	2-10	15	10-25
Pan											9	5-10
FM									2.54	2.4-3.1	2.54	2.25-2.85

ADDRESS REPLY TO
DIRECTOR
(NOT TO INDIVIDUALS)

U. S. ARMY ENGINEER DIVISION, NORTH PACIFIC
CORPS OF ENGINEERS
NORTH PACIFIC DIVISION MATERIALS LABORATORY
RT. 2, BOX 12A
TROUTDALE, OREGON

NPDEN-GS-L (64-CPCh-188)

7 May 1965

SUBJECT: Snettisham Project, Report of Laboratory Investigations of Granite Ledge Rock Sample

TO: District Engineer
U. S. Army Engineer District, Alaska
ATTN: NPAEN-FM

1. Reference is made to:

a. Your letter of 6 January 1965, subject, "Letter of Transmittal to Accompany Concrete Aggregate Materials" applicable to a 3,600 pound sample of rock received at this laboratory 22 December 1964.

b. Reports forwarded under cover of our 29 January 1965 letter, subject as above.

c. Telephone conversations 30 April 1965 between Messrs. Jones, Knoppe, Clarke and the writer wherein it was agreed to reschedule mortar bar expansion tests and to perform one trial concrete mix design using available rock with compressive strength specimens for three test ages (7, 28 and 90 days) using aggregate processed to 1½" top size.

2. Attached completing all work scheduled except that outlined in reference 1c above are: (Incl.1) A one page summary report of aggregate tests, (Incl.2) a five page report of petrographic examinations of the aggregate plus data sheets of referenced similar manufactured aggregate for NPW Dworshak Dam and two summary tabulations and (Incl.3) NPD Form 361 report of the results of CRD C-114 freeze-thaw soundness test with a one page report of petrographic examinations after test and one photo illustration.

3. Reports on remaining scheduled testing referenced in 1c above will, unless otherwise requested, be forwarded when 90 day results become available on or about 16 August 1965.

3 Incl
as (Reproducibles w/2 copies)

J. L. Bargar
J. L. BARGAR
Director

AIR MAIL

MIX DATA

MATERIAL	% C.A.	SAMPLE NO.	SOLID VOLUME cu ft	WEIGHTS S.S.D. lb	BULK SP. GR. S.S.D.	% ABSORP.
Coarse Agg (A)						
" " (B)						
" " (C)	45	12937	5.366	887	2.65	0.4
" " (D)	55	"	6.562	1069	2.61	1.4
Sand		"	6.768	1119	2.65	0.5
Cement		12895	1.674	114.0	3.15	
Pozzolan		12064	0.717	329.0	2.55	
Water			4.293	267.9		
Air (6.0% on -1½)			1.620			
Totals			27.000	3786		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	Gallons per bag, equivalent cement	6.43
	By weight, " "	0.57
	By weight, water / (cement + pozzolan)	0.605
Cement factor, bags/cu yd (Eq. Sol. Vol. as P.C.)		5.0
Pozzolan, % replacement by solid volume		30.0
Slump, inches (2 - 2½)		2
Air content (Note 1), % (5.8 - 6.0)		5.9
Unit weight, lbs/cu ft		140.4
Bleeding (Note 2), %		5.5
Sand/aggregate, % by volume		38.0
Temperature of plastic concrete, °F		67

STRENGTH TEST DATA (Compressive)

Age, days	3	7	28
Strength, psi (average)	800	1120	2320
Age, days	90		
Strength, psi (average)	3420		

NOTES:
1. In that portion of the concrete containing aggregate smaller than the 1½" - inch sieve.
2. Percentage of mix water separating from concrete in bleeding test.

REMARKS Mix was proportioned to approximately a 3.25 sk, 6" max. mix with plus 1½" aggregate removed.

	Batch	Air	Slump	Comp. Str. PSI 3-Day	7-Day	28-Day	90-Day
Room Dry Aggregate	1	5.8	2	790	1070	2320	3350
				800	1110	2300	3510
	2	6.3	2½	760	1100	2280	3330
				770	1060	2260	3230
	3	5.8	2	840	1150	2350	3560
				850	1200	2380	3550
Pre-Soaked Aggregate		5.4	2½		810	2140	3100
					950	1920	3030
Avg.					880	2030	3070

SCREEN ANALYSES-% RETAINED

SIEVE SIZE	(A) 6" to 3"	(B) 3" to 1½"	(C) 28.7 1½" to ¾"	(D) 35.1 ¾" to 4	36.2 Sand	Combined Coarse Aggregate	Combined Total Aggregate
7"							
6"							
5"							
4"							
3"							
2½"							
2"							
1½"						0	0
1"			66			29.7	19.0
¾"			28	9		47.3	30.2
½"			4	31		66.1	42.2
⅜"				25		79.8	51.0
4			1	30		96.7	62.0
8			1	5	8		65.2
16					18		72.3
30					27		83.0
50					23		92.0
100					15		98.0
PAN					9	100.0	100.0
F. M.					2.54		

PROJECT SNETTISHAM PROJECT

DISTRICT Alaska

FINE AGGREGATE Lab-produced granite sand (Rodmill product)

COARSE AGGREGATE Lab-crushed granite

CEMENT Blended Type II, LA. Blend of equal parts Ideal (Gold Hill), Oregon (Lake-Oswego) & Permanente (Bellingham)

POZZOLAN Idealite (Calcined Shale) Great Western Aggregates Co. Laramie, Wyoming

A.E.A. Lab Stock NVX (Lab No. 13076) 310 cc/cu.yd.

OTHER ADMIXTURE None

MIX NO. 13114 | W/O NO. 64-CP-188

CAST 5/14/65

AUG 20 1965 (Date of Report)

D. L. Houghton, Chief, Concrete Branch

NPD RF APRIL 61 359 — REPORT OF CONCRETE MIXTURE DESIGN METHODS CRD-C 3 AND 10 — CORPS OF ENGINEERS NORTH PACIFIC DIVISION TESTING LABORATORY

Incl 1

NBS 539 B
(Rev. 12/12/63)

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C. 20234

North Pacific Division Laboratory
Attention: Mr. J. L. Eargar, Director
Corps of Engineers
Route 2, Box 12A
Troutdale, Oregon

Seattle, Washington 98107
October 29, 1964

NATIONAL BUREAU OF STANDARDS

REPORT OF TEST
PORTLAND CEMENT

Date:
File No.

NBS Test No. MS-9943 Specification SS-C-00192f, (COM-NBS), II, low alkali
Company *Composite Location Bin No.
Dates sampled October 20, 1964, sample submitted by Corps of Engineers. Barrels represented
This cement does ______ meet the specification requirements.

SAMPLE NOS.	IGN. LOSS %	INSOL. RES. %	SO_3 %	MgO %	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	$C_3S + C_3A$ %	C_3A %	C_2S %	C_4AF %	TOTAL ALKALI AS Na_2O %	COMP. STRENGTH LBS./SQ. IN. 3-DAY	7-DAY	AIR ENTR. %	BLAINE SPECIFIC SURFACE cm^2/g
NPD 12895	1.2	0.1	1.9	1.7	22.5	4.4	3.5	55	5.7	27	11	0.44	2280	3270	8.4	3590
													*28-Day 4870			

	AUTO. EXPAN. %	TIME OF SET Initial (hr. min.)	Final (hr. min.)		AUTO. EXPAN. %	TIME OF SET Initial (hr. min.)	Final (hr. min.)
1-2	-0.01	3:50	6:20	21-22			
3-4				23-24			
5-6				25-26			
7-8				27-28			
9-10				29-30			
11-12				31-32			
13-14				33-34			
15-16				35-36			
17-18				37-38			
19-20				39-40			

REMARKS: Heat of hydration 67 cal./ gm.
*NPD 12895 composite sample consisting of:
NPD 12765 - Ideal, Gold Hill
NPD 12832 - Oregon, Lake Oswego
NPD 12894 - Permanente, Bellingham

Alkalies Na_2O	K_2O	CaO	Free CaO
0.23	0.32	64.0	0.8%

Refer: Your letter 20 October 1964, NPDEN-GS-L. Charge costs to 96x4902 Revolving Fund, Acct. 441.3.1.3, W. O. 62-CPCh-68.

Note: 28 day supplementary report will follow.

The contents of this report are for your information and shall not be used in advertising or sales promotion to indicate either explicitly or implicitly endorsement of this product by the National Bureau of Standards.

cc: Institute for Applied Technology, NBS, Washington, D. C.
*Reported by NBS Fm 539 B, 18 Nov 64.

For the Director

Frank N. Winblade
Chief, Seattle Laboratory
Inorganic Building Materials Sec.
Building Research Division

Concrete

: 28 day attached ... file

☆ U. S. GOVERNMENT PRINTING OFFICE: 1964–718-001

INCL 2

STATE: Idaho	INDEX NO. 3 (Supple #1)	AGGREGATE DATA SHEET	TESTED BY: North Pacific Division
LAT: 46	LONG: 116		DATE: 1961

LAB. SYMBOL NO.: 61-CPCh-2 TYPE OF MATERIAL: Ledge Rock

LOCATION: Proposed Granite-Gneiss Quarry, $S\frac{1}{2}$, $NW\frac{1}{4}$, Sec. 35, T-37-N, R-1-E, BM. About $\frac{1}{4}$ mile downstream from dam axis, left bank North Fork Clearwater River

PRODUCER: Undeveloped

SAMPLED BY: NPW Personnel

TESTED FOR: Bruces Eddy Dam on North Fork Clearwater River, Idaho

PROCESSING BEFORE TESTING: Laboratory processed in jaw and gyratory crushers and rod-mill and rake classifier. (Bulk sample obtained by blasting face of ledge rock).

GEOLOGICAL FORMATION AND AGE: Laramide Orogenic Epoch (Cretaceous)

GRADING (CRD-C 103) (CUM. % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.	93				
5 IN.	61				
4 IN.	24				
3 IN.	1	100			
2½ IN.		81			
2 IN.		55	100		
1½ IN.		9	90	100	
1 IN.			40	99	
¾ IN.			10	97	
½ IN.				71	
⅜ IN.				43	100
NO. 4				9	98
NO. 8					87
NO. 16					73
NO. 30					53
NO. 50					32
NO. 100					11
NO. 200					
- 200(a)					2
F.M.(b)					2.46

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	¾-1½" (c)	#4-¾" (c)	FINE AGG.
BULK SP. GR., SAT. SURF. DRY (CRD-C 107,108):	2.77	2.78	2.77	2.76	2.77
ABSORPTION, PER CENT (CRD-C 107, 108):	0.3	0.1	0.5	1.0	0.3
ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):	—	—	—	—	1
SOFT PARTICLES, PER CENT (CRD-C 130):					—
PER CENT LIGHTER THAN SP. GR. ____ (CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120):	Trace	3.4	1.3	4.7	9.6
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((c) ½-1", #4-½) (CRD-C 115)			0.6		17.5
ABRASION LOSS (L. A.), %, (CRD-C 117): A Grad	39	B Grad.		15	—
UNIT WT., LB/CU FT (CRD-C 106):	92	95	99	95	105
CLAY LUMPS, % (CRD-C 118)					
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C ~~xxx~~ 242)	.185	.185	.185	.185	.185
REACTIVITY WITH NaOH (CRD-C 128): Sc, mM/L					
Rc, mM/L					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE II CEMENT, RATIO 7 DAYS, 113 %, 28 DAYS, 106 %

LINEAR THERMAL EXPANSION X10 $^{-6}$/DEG. F. (CRD-C 125,126):

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE
Quartz-Feldspar	2.3	3.7		3.0
Gneiss	2.7	3.4		3.1
Hard Schist	3.5	3.4	3.8	3.6

MORTAR:

MORT. BAR EXPANSION AT 100F, % (CRD-C 123):	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: 0.45 % Na_2O EQUIVALENT:								
HIGH-ALK. CEMENT: 1.10 % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):			F & T	HW-CD	HD-CW
FINE AGG. Rod-mill	COARSE AGG: Crushed Gneiss	DFE_{300}	57		
FINE AGG.	COARSE AGG:	DFE_{300}			

PETROGRAPHIC DATA (CRD-C 127): Hornblende-biotite-quartz diorite gneiss (commonly called granite gneiss): 85% medium to coarse grained gneiss, 10% fine grained hard schist that does not split easily, and 5% medium to fine grained quartz feldspar rock. Gneiss: 45-55% plagioclase feldspar, 20-30% hornblende and biotite, 15-20% quartz, and 10-15% accessory minerals. Hard schist: 40-50% hornblende and biotite, 30-40% quartz, and 10-20% plagioclase feldspar and minor accessory minerals. Quartz-feldspar rock: 60% plagioclase and 40% quartz, traces of accessories. No alkali-reactive constituents. Angular particles of fresh rock, except for minor hydrothermal alteration. Sand same composition, except 30% discrete mineral grains. Sand 3% soft (NPD Red Devil Shaker Test Method)

REMARKS:

WES FORM 726 JAN. 1951

STATE: Idaho	INDEX NO: 3(Supl 2&3, Rev.)	AGGREGATE DATA SHEET	TESTED BY: North Pacific Division
LAT: 46	LONG: 116		DATE: 1961-1964

LAB. SYMBOL NO: W.O. 61-CPCh-2 & 62-CPCh-68 TYPE OF MATERIAL: Gneiss Ledge Rock

LOCATION: Proposed granite gneiss quarry, left bank North Fork Clearwater River, from stream bank to elev. 2300', test quarry and tunnel QT-1 of quarry area 3, within 1 mile downstream "A" dam axis, Sec. 35, T-37-N, R-1-E, BM.

Producer: Undeveloped

SAMPLED BY: NPW Personnel

TESTED FOR: Dworshak (Bruces Eddy) Dam, North Fork Clearwater River, Idaho

PROCESSING BEFORE TESTING: Laboratory processed in jaw and gyratory crushers and rod-mill and rake classifier. (Bulk sample obtained by blasting face of ledge rock and 100 ton bulk sample from tunnel excavation, in 1962 & 1963.

GEOLOGICAL FORMATION AND AGE: Orofino Series, Laramide Orogenic Epoch (Cretaceous)

GRADING (CRD-C 103)(CUM. % PASSING)

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.	95				
5 IN.	71				
4 IN.	25				
3 IN.	5	100			
2½ IN.	0	67			
2 IN.		33	100		
1½ IN.		5	94		
1 IN.		0	44	100	
¾ IN.			9	96	
½ IN.			2	58	
⅜ IN.				30	
NO. 4				4	100
NO. 8					81
NO. 16					56
NO. 30					40
NO. 50					24
NO. 100					10
NO. 200					
-200[a]					2.3
F.M.[b]					2.89

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	¾-1½" (c)	#4-¾" (c)	FINE AGG
BULK SP. GR., SAT. SURF. DRY (CRD-C 107,108):	2.74	2.76	2.74	2.72	2.72
ABSORPTION, PER CENT (CRD-C 107,108):	0.3	0.3	0.3	0.8	0.6
ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):	—	—	—	—	1
SOFT PARTICLES, PER CENT (CRD-C 130):					—
PER CENT LIGHTER THAN SP.GR.___ (CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120):	2.0	3.6	1.4	2.5	5.7
WEIGHTED AV % LOSS, 5 CYC. $MgSO_4$ ((c) ½-1", #4-½) (CRD-C 115)			--0.1--		2.5
ABRASION LOSS (L.A.), %, (CRD-C 117): "A" Grad.			--31.8--		—
UNIT WT., LB/CU FT (CRD-C 106):	100	99	97	97	108
CLAY LUMPS, % (CRD-C 118)					
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 242 -		0.183 ----			0.189
REACTIVITY WITH NaOH (CRD-C 128) Sc, mM/L					
Rc, mM/L					

MORTAR-MAKING PROPERTIES (CRD-C 116) (104) (flexural) (123)

TYPE II CEMENT, RATIO 7 DAYS, 118 %, 28 DAYS, 111 %

LINEAR THERMAL EXPANSION X10⁻⁶/DEG. F. (CRD-C 125,126):

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE
Quartz feldspar	2.3	3.7		3.0*
Gneiss	2.7	3.4		3.1*
Hard Schist	3.5	3.4	3.8	3.6*
Coarse gneiss	3.5	3.6	3.8	3.6
~~MORTAR~~ Mod. Gneiss	4.2	3.7	3.3	3.8

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):

	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: 0.385% Na_2O EQUIVALENT:	0.013	0.017	0.015	0.022	*			
HIGH-ALK. CEMENT: 0.972% Na_2O EQUIVALENT:	0.012	0.012	0.007	0.013	*			

SOUNDNESS IN CONCRETE (CRD-C 40, 114):

			F & T	HW-CD	FD-CW
FINE AGG.	COARSE AGG:	DFE_{300}			
FINE AGG. Rod-mill	COARSE AGG: Crushed gneiss	DFE_{300}	69		

PETROGRAPHIC DATA (CRD-C 127): Hornblende-biotite-quartz diorite gneiss (commonly called granite gneiss): 85% medium to coarse grained gneiss, 10% fine grained hard schist that does not split easily, and 5% medium to fine grained quartz feldspar rock. Minor amounts of garnet rock, marble, and basalt dike material in quarry areas. Typical gneiss: 45-55% plagioclase feldspar, 20-30% hornblende and biotite, 15-20% quartz, and 10-15% accessory minerals. No alkali-reactive constituents. Fresh rock, except for minor hydrothermal alteration and weathering near surface. Sand has 30% discrete mineral grains of which 15% are free mica flakes. Subject to mixer-grinding due to cleavable feldspar and mica.

REMARKS: * Data from W.O. 61-CP-2, river bank quarry site; rest of data from W.O. 62-CPCh-68, tunnel sample. Sand 3% soft by NPD Shaker Test.

Mix No. A-2

MIX DATA						
MATERIAL	% C.A.	SAMPLE NO.	SOLID VOLUME cu ft	WEIGHTS S.S.D. lb	BULK SP. GR. S.S.D.	% ABSORP.
Coarse Agg(A)	30	11778	5.185	886	2.74	0.3
" " (B)	30	"	5.185	893	2.76	0.3
" " (C)	20	"	3.449	590	2.74	0.3
" " (D)	20	"	3.449	585	2.72	0.8
Sand		"	4.426	751	2.72	0.6
Cement		12078	1.088	213.8	3.15	
Pozzolan		12064	0.466	74.1	2.55	
Water			2.742	171.1		
Air (6.0% on-1½)			1.010			
Totals			27.000	4164		

SCREEN ANALYSES-% RETAINED							
SIEVE SIZE	NOMINAL SIZES (A) 6" to 3"	(B) 3" to 1½"	(C) 1½" to ¾"	(D) ¾" to 4	Sand	COMBINED Coarse Aggregate	Total Aggregate
7"	0					0	0
6"	5					1.6	1.3
5"	24					8.7	6.9
4"	46					22.5	17.9
3"	20					28.5	22.7
2½"	5	33				39.9	31.8
2"		34				50.1	39.9
1½"		28	6			59.7	47.6
1"		5	50			71.2	56.6
¾"			35	4		79.0	62.9
½"			7	38		88.0	70.0
⅜"			2	28		94.0	74.8
4				26		99.2	79.0
8				4	19		83.0
16					25		88.3
30					16		91.4
50					16		95.0
100					14		98.0
PAN					10	100.0	100.0
F. M.					2.89		

MIX CHARACTERISTICS		
WATER-CEMENT RATIO	Gallons per bag, equivalent cement	6.32
	By weight, " "	0.56
	By weight, $\frac{\text{water}}{\text{cement + pozzolan}}$	0.594
Cement factor, bags/cu yd (Eq. Sol. Vol. as P.C.)		3.25
Pozzolan, % replacement by solid volume		30.0
Slump, inches (2-2½)		2
Air content (Note 1), % (5.8-6.6)		6.2
Unit weight, lbs/cu ft (Theoretical)		154.0
Bleeding (Note 2), %		3.5
Sand/aggregate, % by volume		21.0
Temperature of plastic concrete, °F		67

STRENGTH TEST DATA (Compressive)			
Age, days	3	7	28
Strength, p s i (average)	840	1050	2270
Age, days	90	180	365
Strength, p s i (average)	3640	4020	4480

NOTES:
1. In that portion of the concrete containing aggregate smaller than the 1½" - inch sieve.
2. Percentage of mix water separating from concrete in bleeding test.

REMARKS Compressive strengths are average of six cylinders: two from each of three batches.

PROJECT BRUCES EDDY DAM

DISTRICT Walla Walla (E-278)

FINE AGGREGATE Laboratory produced granite-gneiss sand; 50/50 blend of No. 4 - No.16

COARSE AGGREGATE Laboratory crushed granite-gneiss

CEMENT Blended Type II cement, 25% each, Ideal, Lehigh, Oregon and Permanente

POZZOLAN Idealite (calcined shale) Great Western Aggregates Company, Laramie, Wyoming

A.E.A. Lab Stock NVR, (#11356) 426 cc/cu.yd.

OTHER ADMIXTURE None

MIX NO. 12128	W/O NO. 62-CPCh-68
CAST 1/28/63	
AUG 20 1965 (Date of Report)	O. E. BORGE Act'g Chief, Concrete Branch

NPD RF 359 APRIL 61

REPORT OF CONCRETE MIXTURE DESIGN
METHODS CRD-C 3 AND 10
CORPS OF ENGINEERS NORTH PACIFIC DIVISION TESTING LABORATORY

Mix No. C-2

MIX DATA

MATERIAL	% C.A.	SAMPLE NO.	SOLID VOLUME cu ft	WEIGHTS S.S.D. lb	BULK SP. GR. S.S.D.	% ABSORP.
Coarse Agg(A)						
" " (B)						
" " (C)	50	11778	5.744	982	2.74	0.3
" " (D)	50	"	5.744	975	2.72	0.8
Sand		"	7.283	1236	2.72	0.6
Cement		12078	1.674	329.0	3.15	
Pozzolan		12064	0.717	114.1	2.55	
Water			4.218	263.2		
Air 6.0 % on-1½)			1.620			
Totals			27.000	3899		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	Gallons per bag, equivalent cement	6.32
	By weight, " "	0.56
	By weight, water / (cement + pozzolan)	0.594
Cement factor, bags/cu yd (Eq. Sol. Vol. as P.C.)		5.0
Pozzolan, % replacement by solid volume		30.0
Slump, inches		2
Air content (Note 1), %		5.8
Unit weight, lbs/cu ft		144.7
Bleeding (Note 2), %		-
Sand/aggregate, % by volume		40.0
Temperature of plastic concrete, °F		66

STRENGTH TEST DATA (Compressive)

Age, days	3	7	28
Strength, psi (average)	840	1120	2320
Age, days	90	180	365
Strength, psi (average)	3700		

NOTES:
1. In that portion of the concrete containing aggregate smaller than the 1½"-inch sieve.
2. Percentage of mix water separating from concrete in bleeding test.

REMARKS
1½" Max. version of Mix A-2

SCREEN ANALYSES-% RETAINED

SIEVE SIZE	NOMINAL SIZES (A) 6" to 3"	(B) 3" to 1½"	(C) 1½" to ¾"	(D) ¾" to 4	Sand	COMBINED Coarse Aggregate	Total Aggregate
7"							
6"							
5"							
4"							
3"							
2½"							
2"						0	0
1½"			6			3.0	1.8
1"			50			23.0	14.1
¾"			35	4		47.5	29.1
½"			7	38		70.0	42.9
⅜"			2	28		85.0	52.0
4				26		98.0	60.0
8				4	19		67.5
16					25		77.4
30					16		83.6
50					16		89.9
100					14		95.3
PAN					10	100.0	100.0
F. M.					2.89		

PROJECT
BRUCES EDDY DAM

DISTRICT Walla Walla (E-278)

FINE AGGREGATE Laboratory produced granite-gneiss sand; 50/50 blend of No. 4 - No. 16 and minus No. 16

COARSE AGGREGATE
Laboratory crushed granite-gneiss

CEMENT
Blended Type II cement, 25% each, Ideal, Lehigh, Oregon and Permanente

POZZOLAN
Idealite (Calcined Shale) Great Western Aggregates Company, Laramie, Wyoming

A.E.A. Lab. stock NVR (#11356)
320 cc/cu.yd.

OTHER ADMIXTURE
None

MIX NO. 12258
CAST 4/28/63

W/O NO.
62-CPCh-68

AUG 20 1965
(Date of Report)

O. E. BORGE
Actg. Chief, Concrete Branch

NPD RF APRIL 61 359

REPORT OF CONCRETE MIXTURE DESIGN
METHODS CRD-C 3 AND 10
CORPS OF ENGINEERS NORTH PACIFIC DIVISION TESTING LABORATORY

LABORATORY: National Bureau of Standards Seattle, Washington	REPORT OF TESTS ON POZZOLAN (CRD-C 262)	REPORT NO.: MS-0900 DATE: 21 December 1962

CLASS: X N — KIND OF POZZOLAN: Calcined Shale

SOURCE: Great Western Aggreg Co., Wyoming — BRAND: Idealite

FOR USE AT: NPD Laboratory Dworshak Dam concrete investigation

DISTRICT(S): Walla Walla

SAMPLED BY: NPD Lab. — DATE SAMPLED:

CAR NO.: - — BIN NO.: -

FIELD SAMPLE NO.: — LAB SAMPLE NO.: 12064

DATE RECEIVED: 27 November 1962 — LAB JOB NO.: 62-CPCh-68

CONTRACT NO.:

QUANTITY REPRESENTED (1000 T OR LESS): 82 sacks

TESTED BY: NBS Lab., Seattle, Washington

CHECKED BY:

TESTS ON COMPOSITE SAMPLES REPRESENTING 1000 TONS OR LESS

	$SiO_2 + Al_2O_3 + Fe_2O_3$ %	MgO %	SO_3 %	AVAILABLE ALKALIES %	POZZOLAN STRENGTH % CONTROL	INCREASE IN SHRINKAGE % (a)	AUTOCLAVE EXPANSION %	REDUCTION IN EXPANSION % (b)
REQUIREMENTS	MIN 70.0	MAX 5.0	MAX 4.0	MAX 1.5	MIN 75	MAX 0.03	MAX 0.50	MIN 75
TEST RESULTS	91.8	2.3	0.3	0.9	98	0.01	0.00	-

TESTS ON SAMPLES REPRESENTING 100 TONS OR LESS

	SAMPLE NO.	MOISTURE CONTENT %	LOSS ON IGNITION %	AIR PERMEABILITY FINENESS SQ CM/CC (AVERAGE)	FINENESS VARIATION FROM AVERAGE OF PRECEDING 10, %	LIME POZZOLAN STRENGTH PSI	WATER REQUIREMENT, INCREASE IN FLOW %	SPECIFIC GRAVITY	SPECIFIC GRAVITY VARIATION FROM AVERAGE OF PRECEDING 10, %
REQUIREMENTS	—	MAX 3.0	MAX 10.0 (N) 6.0 (F)	MIN 6500	MAX 20	MIN 900	MIN 0	—	MAX 5
TEST RESULTS	12064	0.1	0	20,900	-	1350	35	2.55	-
AVERAGE		—	—		—	—	—		—

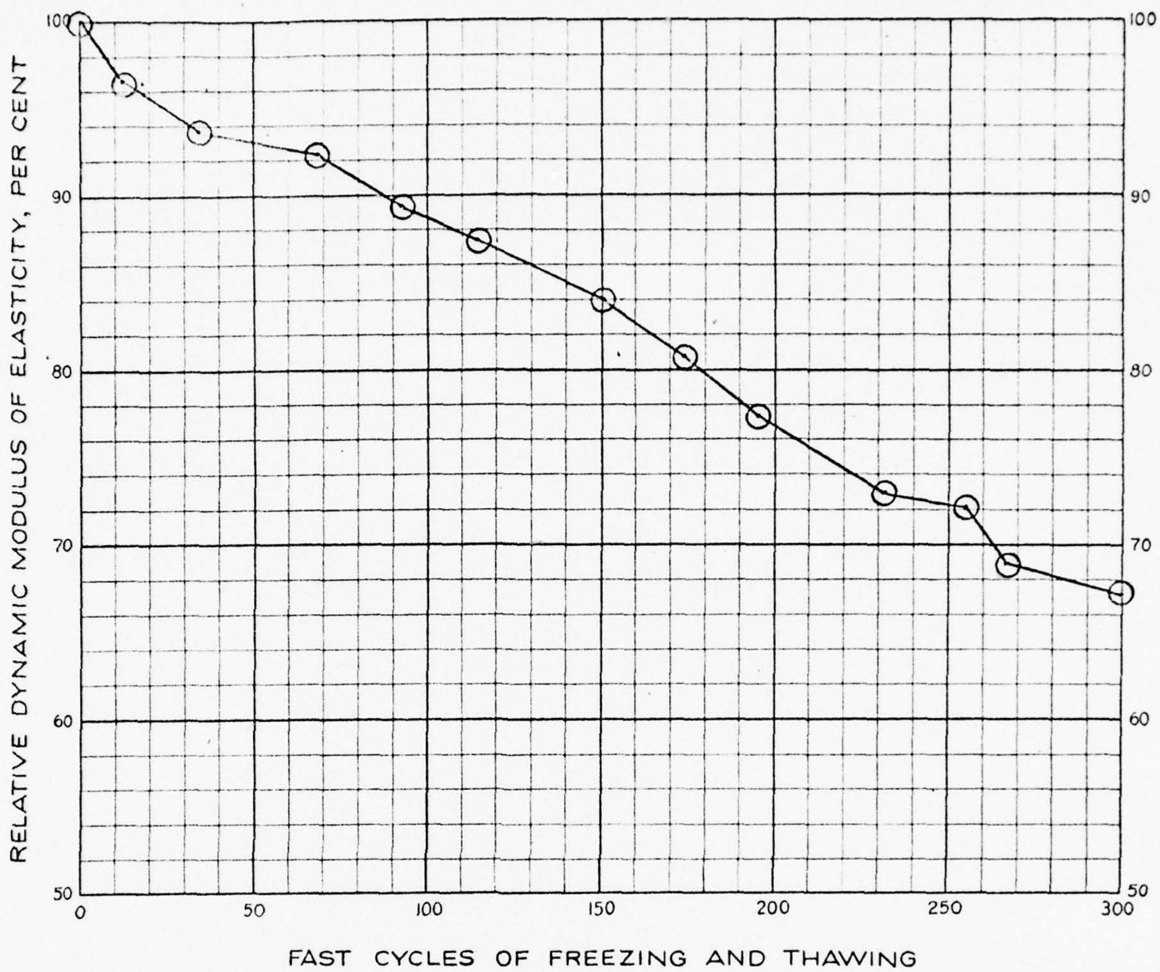
(a) APPLICABLE ONLY TO CLASS N
(b) OPTIONAL REQUIREMENT

Identification of cement used in tests, NPD Lab. No. 12078

REMARKS:

ENG FORM 1 NOV 62 3000-R

Incl 3



BEAM NO.	SYMBOL	DFE AT 300 CYCLES	NO. CYCLES REL. E = 50%
13002		70.2	
13002-A		66.1	
13002-B		65.7	
Grand Avg.	O	67.3	

REMARKS

PROJECT SNETTISHAM

DISTRICT Alaska

FINE AGGREGATE

Rod-mill sand processed from blasted Granite Ledge rock sample.

COARSE AGGREGATE

Crushed gravel processed from blasted Granite Ledge rock sample.

Plotted JP	W/O NO.
Checked OEB	64-CPCh-188
30 Apr 65 (Date of Report)	D. L. HOUGHTON Chief, Concrete Branch

NPD FORM 361 JUNE 49

RESISTANCE OF CONCRETE BEAMS TO ACCELERATED FREEZING AND THAWING

CORPS OF ENGINEERS NORTH PACIFIC DIVISION TESTING LABORATORY

Incl. 3

ADDRESS REPLY TO
DIRECTOR
(NOT TO INDIVIDUALS)

U. S. ARMY ENGINEER DIVISION, NORTH PACIFIC
CORPS OF ENGINEERS
NORTH PACIFIC DIVISION MATERIALS LABORATORY
RT. 2, BOX 12A
TROUTDALE, OREGON

NPDEN-GS-L (64-CPCh-188) 20 August 1965

SUBJECT: Snettisham Project, Report of Laboratory Investigations of Granite Ledge Rock Sample

TO: District Engineer
U. S. Army Engineer District, Alaska
ATTN: NPAEN-FM

1. Reference is made to:

a. Your letter of 6 January 1965, subject: "Letter of Transmittal to Accompany Concrete Aggregate Materials" applicable to a 3600 pound sample of rock received at this laboratory 22 December 1964.

b. Reports forwarded under cover of our letters of 29 January and 7 May 1965.

2. Attached is report which includes:

a. NPD Form 359, Report of Concrete Mixture Design, with concrete strengths through 90-days age for 1½-inch maximum size aggregate mix NPD Lab. No. 13114.

b. NPD Form 359 for Dworshak Dam 6-inch mass mix No. 12128.

c. NPD Form 359 for Dworshak Dam mix No. 12258, a 1½-inch max version of 6-inch mass mix No. 12128.

d. NBS Report of Test Portland Cement for lab stock blended cement, NPD Lab No. 12895, used in the Snettisham mix.

e. ENG Form 6000R, Report of Tests on Pozzolan for pozzolan NPD Lab No. 12064, Idealite (calcined shale) which was used in the Snettisham and Dworshak mixes.

f. First quarter report of the alkali-aggregate reactivity mortar bar expansion tests.

3. Since laboratory stock of Snettisham aggregate was limited, particularly the plus 1½-inch sizes, a 6-inch mass mix could not be batched for this study. However, a 1½-inch maximum aggregate mix was proportioned on the basis of a 6-inch mix with the plus 1½-inch aggregate excluded. Data

for this mix No. 13114 is given on an attached Form 359. To give you additional information on this batching technique we have attached mix design data for two Dworshak Dam mixes, Nos. 12258 and 12128 in which this method was used. Mix No. 12258, a $1\frac{1}{2}$-inch maximum mix was designed to be the equivalent of mix No. 12128, a 6-inch mix, with the plus $1\frac{1}{2}$-inch aggregate excluded. The study was made to see the correlation in strength of the two comparable mixes having different maximum size aggregates. This Dworshak mix data has significance with regard to the Snettisham investigation in that the aggregates of the two projects are similar in physical characteristics. It is interesting to note also that to date strength developing characteristics for these mixes having similar water cement ratios are relatively equivalent.

The Snettisham mix was batched by two methods, the conventional NPD method using air-dried aggregate and a newer pre-soaked aggregate method. In the conventional method, air-dried aggregates having a known moisture content are weighed and batched into the mixer. Net aggregate absorption during mixing and plactic test period is allowed for on the basis of 70 percent of the 24 hour net absorption value. For the pre-soaked mixes, air-dried aggregates having a known moisture content are weighed and soaked in water overnight. Aggregate batches are then drained and accurately weighed prior to charging the mixer. Increased aggregate batch weight represents absorbed and free moisture, and the difference between that and the total prescribed batch water represents water to be added to the mix.

4. Results of the mortar bar expansion tests are inconclusive at this time. Six months results should indicate a definite trend.

5. The second quarter report of the alkali-aggregate reactivity mortar bar expansion tests will be forwarded about 20 October 1965.

J. L. Bargar
J. L. BARGAR
Director

4 Incl (in dupe)
1. NPD Fm 359's
2. NBS Rpt Portland Cement
3. ENG Rpt Pozzolan
4. First quarter rpt, MBE

REPORT OF ALKALI-AGGREGATE REACTIVITY MO

Set No.	Cement *	Aggregate	Expa 8-Day	1-Mo.	2-Mo.	3-Mo.	4-Mo.	5-Mo
12955-1	High Alk.	Lab-processed	0.005	0.009	0.012	0.012		
	Low Alk.		0.001	-0.002	0	0.005		
12955-2	High Alk.		0.003	0.005	0.008	0.011		
	Low Alk.		-0.001	0	0.002	0.008		
12955-3	High Alk.		0.001	0.005	0.012	0.012		
	Low Alk.		-0.001	0.004	0.007	0.011		

* Note: Alkali content of cement expressed as percent Na_2O: High Alkali 0.972
Low Alkali 0.385

OJECT

Aug 20, 1965

Y MORTAR BAR EXPANSION TESTS

Expansion, Percent							
-Mo.	6-Mo.	7-Mo.	8-Mo.	9-Mo.	10-Mo.	11-Mo.	12-Mo.

PART 5 CONCRETE AGGREGATE - COST STUDY A, B & C

PROJECT

SNETTISHAM AGGREGATE SOURCES

BID ITEM				PLANT	MOBILIZATION AND DEMOBILIZATION	LA
NO.	DESIGNATION	UNIT	QUANTITY			
	SOURCE "A" LONG LAKE	CY	90,000	$346,568	70,662	218,60
	SOURCE "B" GLACIER CREEK	CY	90,000	492,912	50,230	247,79
	SOURCE "C" DAM SITE LEDGE ROCK	CY	90,000	305,240	50,230	156,63

OVERNMENT ESTIMATE DETAIL SUMMARY SHEET

	MATERIALS	SUPPLIES	SUBTOTAL	DISTRIBUTED COSTS 30%	TOTAL COSTS (Excluding Bonds)	BOND COST	TOTAL COST (Including Bonds)	UNI CO
			635,834	190,750	826,584		826,584	9.
			790,939	237,282	1,028,221		1,028,221	11.
	98,701		610,801	183,240	794,041		794,041	8.

SHEET OF		
	ADJUSTED	
	UNIT COST	AMOUNT
3	9.25	832,500
2	11.40	1,026,000
2	9.00	810,000

GPO 850 4-295

COMP. ______ CHKD. ______

CORPS OF ENGINEERS
ALASKA DISTRICT
ANCHORAGE, ALASKA

SHEET NO. ______ FILE ______

SUBJECT SNETTISHAM AGGREGATE SOURCE "A"

MOBILIZATION COSTS:

	MACHINE	WEIGHT (LBS)
1	SHOVEL	55,000
1	PUMP	900
1	DOZER	42,800
1	FRONT END LOADER	23,100
1	TRUCK 2½ TON	7,000
3	CONVEYOR	69,000
1	CONVEYOR	80,000
1	CRUSHER	72,000
1	RESCREENING PLANT	57,000
	GATES, PIPES, BULKHEADS	20,000
1	BARGE	145,000
	TOTAL WT.	572,200 LBS

TRANSPORT. COST @ 3.25/100 LBS

5722 x 3.25 = 18,597 $

LOAD EQUIPM. AT YARD AND HAUL TO BARGE

10 MEN - 2 DAYS @ 4.0 $/HR

160 x 4.00 - 640 $
TRANSPORTATION COST 1,500

UNLOAD AND RE-ASSEMBLE EQUIPM.
12 MEN - 30 DAYS @ 5.97 $/HR.

96 x 30 x 5.97 - 17,194 $
COMP & LIAB. INC. @ 13.72% = 17,834 x .1372 = 2,447 $

TOTAL MOBIL. COST = 40,378 $
DEMOB. COST 75% = 30,284 $
TOTAL MOBIL & DEMOBIL. COST = 70,662 $

NPA FORM NOV. 1961 168a (Rev.) Previous editions obsolete.

GOVERNMENT ESTIMATE WORK SHEET

SHEET 1 OF

PROJECT
SNETTISHAM

SUBJECT
AGGREGATE SOURCE "A"

QUANTITY
90,000 CY

AVAILABLE OPERATION TIME IN

CALENDAR DAYS | WORKING DAYS

PLAN OF OPERATIONS: IN THIS STUDY ALL AGGREGATES ARE PRODUCED IN ONE CONSTRUCTION SEASON AND STOCKPILED NEAR GRAVEL PIT AREA.

ASSUME 30% REJECT AND STOCKPILE ADDITIONAL 25%.

$\frac{90,000 \times 1.25}{.7}$ = 160,500 C.Y.

SAY 6 acres ARE TO BE CLEARED AND GRUBBED
@ 500 $/acre COST 3,200 $

USE 1 C.Y. SHOVEL CAP./HOUR = 180 C.Y.
USE PORTABLE CRUSHING PLANT CAP. 200 T.P.H.
USE AT 70% EFF $\frac{200 \cdot .7}{1.5}$ = 100 C.Y./HR.

BASE TIME REQU. ON PRODUCTION RATE OF 100 C.Y./HR.

TIME REQU = $\frac{160,500}{100}$ = 1,605 HRS.

AT 16 HRS/DAY TIME REQU = 100 DAYS

DETERMINATION OF CONTROLLING PLANT OR LABOR OUTPUT, AMOUNT OF CONTROLLING PLANT OR LABOR, OPERATIONAL SHIFTS AND SECONDARY PLANT REQUIRED TO ACCOMPLISH WORK IN AVAILABLE WORKING DAYS:

USE 1-200 TON BARGE TO HAUL AGGREGATES TO BATCH PLANT
TIME REQU. FOR ONE TRIP IS 4 HRS
LOADING CAPACITY OF BARGE $\frac{200}{1.5}$ = 133 C.Y.

FROM COMPUTATION FOR STUDY "B" 128,260 C.Y. ARE TO BE HAULED.

TRIPS REQUIRED $\frac{128,260}{133}$ = 964

AT 3 TRIPS/DAY 964/3 = 321 DAYS

TOTAL HRS REQU. 321 x 12 = 3,860 HRS

SUMMARY OF OPERATIONAL TIME

SHIFTS PER DAY	HOURS PER SHIFT	PLANT HOURS	WORKING HOURS

REMARKS

GOVERNMENT ESTIMATE WORK SHEET

SHEET 2 OF 3

SUBJECT: SNETTISHAM SOURCE "1"

QUANTITY:

PLANT

	UNIT OF PLANT	SIZE	NO.	HOURS*	RATE	AMOUNT
RENTAL OR OWNERSHIP EXPENSE	DOZER	100-150 HP	1	1,600	14.10	22,500
	SHOVEL	1 CY	1	1,600	21.70	49,320
	CRUSHING UNIT	200 TPH	1	"	25.00	40,000
	DELIV. CONVEYOR	18"x70'	1	"	7.80	12,480
	CONVEYOR	"	1	"	7.80	12,480
	LOADING CONVEYOR	"	1	"	7.80	12,480
	FUEL TRUCK	2½ Ton	1	800	5.10	4,080
	CONVEYOR (UNLOADING)	18" x 2000'	1	"QUOTE"		75,000
	FRONT END LOADER	2¼ CY	1	1400	12.47	17,458
	PUMP	4"	1	1,600	.91	1,456
	RESCREENING PLANT	5'x12'	1	1,600	6.10	9,760
	GATES, PIPES, BULKHEADS					5,000
OPERATING SUPPLIES AND FIELD REPAIRS	BARGE			18 M	1,000	18,000
	BOAT AND MOTOR		1	L.S.		3,000
	TRUCK 3/4 TON			3,860	2.94	11,348
	"			6 M	202	1,212
	FRONT END LOADER	2¼ CY	1	3,860	12.47	48,134
	"			6 M	1310	7,860
					SUBTOTAL	346,568
		SMALL TOOLS			% OF LABOR	
					TOTAL PLANT COST	

* NOTE: Use calendar hours for plant rental and working hours for plant operating supplies and field repairs.

LABOR

OPERATION	CRAFT	NO.	HOURS**	RATE	AMOUNT
	DOZER OPERATOR	1	1600	5.86	9,376
	SHOVEL "	1	"	6.00	9,600
	CRUSHER "	1	"	5.97	9,552
	CRUSHER OILER	1	"	5.34	8,544
	MECHANIC	1	"	5.97	9,552
	FOREMAN	1	"	7.00	11,200
	TRUCK DRIVER	1	800	5.47	4,376
	LABORER	2	3200	5.30	16,960
			15,600		
	TOTAL			SUBTOTAL	79,160
			OVERTIME 8.33 %		6,594
				SUBTOTAL	85,754
	COMP. & LIAB. INS., SOC. SEC. & STATE EMP. INS.			13.72 %	11,765
(** NOTE: USE WORKING HOURS)				TOTAL LABOR COST	97,519

GOVERNMENT ESTIMATE WORK SHEET

SHEET 2 OF 3

SUBJECT: SNETTISHAM SOAP [illegible]

QUANTITY:

PLANT

	UNIT OF PLANT	SIZE	NO.	HOURS*	RATE	AMOUNT
RENTAL OR OWNERSHIP EXPENSE						
OPERATING SUPPLIES AND FIELD REPAIRS						

* NOTE: Use calendar hours for plant rental and working hours for plant operating supplies and field repairs.

SUBTOTAL	
SMALL TOOLS % OF LABOR	
TOTAL PLANT COST	

LABOR

OPERATION	CRAFT	NO.	HOURS**	RATE	AMOUNT
	LOADER OPERATOR	1	3860	5.89	22,735
	BARGE OPERATOR	1	3860	6.00	23,160
	BELT OPERATOR	2	3860	5.34	41,224
			15440		
TOTAL				SUBTOTAL	87,119
				OVERTIME 22.22 %	19,358
				SUBTOTAL	106,477
				COMP. & LIAB. INS., SOC. SEC. & STATE EMP. INS. 13.72 %	14,608
(** NOTE: USE WORKING HOURS)				TOTAL LABOR COST	121,085

GOVERNMENT ESTIMATE WORK SHEET

SHEET 3 OF 3

SUBJECT SNETTISHAM AGGREGATE SOURCE "A"

QUANTITY

MATERIALS

DESCRIPTION	UNIT	QUANTITY	PRICE	AMOUNT

TOTAL MATERIALS COST

SUPPLIES

DESCRIPTION	UNIT	QUANTITY	PRICE	AMOUNT

TOTAL SUPPLIES COST

SUMMARY FOR TRANSFER TO ENG FORM NO. 1739 OR ENG FORM NO. 1740

PLANT	346,568
LABOR	218,604
MATERIALS	
SUPPLIES	
TOTAL	565,172

REMARKS: *Prices on these items are based on quotations from manufacturers or suppliers.

PREPARED BY G. GROESCHEL

CHECKED BY RB

ENG FORM 1 JAN 49 1741b (Translucent) (EM 1110-2-1302)

COMP. ______ CHKD. ______

CORPS OF ENGINEERS
ALASKA DISTRICT
ANCHORAGE, ALASKA

SHEET NO. ______ FILE ______

SUBJECT SNETTISHAM AGGREGATE SOURCE "B"

COMPUTATIONS FOR MOBILIZATION

MACHINE	WEIGHT (lbs)
1 DRAGLINE	81900
1 PUMP	900
1 DOZER	42800
1 TRUCK 2½ TON	7000
3 TRUCK 20 C.Y	102600
1 CRUSHER	72000
1 RESCREENING PLANT	57400
3 CONVEYOR	69000
GATES, PIPES, BULKHEADS	20000
GRADER	26800
	480,400

FREIGHT @ 3.25/100 lb

4,804 x 3.25 = 15,613 $

LOAD EQUIPMENT AT YARD AND HAUL TO BARGE

10 MEN FOR 2 DAYS @ 4 $/HR

160 x 4 = 640 $

TRANSPORTATION COST - 1500 $

UNLOAD EQUIPMENT AND RE-ASSEMBLE

10 MEN - 20 DAYS

@ 8HRS/DAY = 1,600 HRS

@ 5.97 $/HR = 1,600 x 5.97 = 9,552 $

COMP. & LIAB. INS. 10192 x .1372 = 1,398

TOTAL MOBILIZATION COST 28,703

DEMOBILIZATION 75% 21,527

TOTAL MOBIL. & DIMOBIL. COST 50,230 $

NPA FORM
NOV 19.. (Rev.) Previous editions obsolete.

GOVERNMENT ESTIMATE WORK SHEET

SHEET 1 OF

PROJECT: SNETTISHAM

SUBJECT: AGGREGATE SOURCE "B"

QUANTITY: 90,000 CY

AVAILABLE OPERATION TIME IN

CALENDAR DAYS | WORKING DAYS

PLAN OF OPERATIONS: IN THIS STUDY ALL AGGREGATES ARE PRODUCED IN ONE CONSTRUCTION SEASON AND STOCKPILED NEAR GRAVEL PIT AREA. 25% EXTRA AGGR. ARE STOCKPILED

FROM COURSE AGGREGATE SOURCE ASSUME 50% WASTE (SAND)

COURSE AGGR REQUIRED $\frac{90000 \times 2954}{2000} = 132,930$ TONS

FOR FINE AGGREGATE SOURCE ASSUME 50% WASTE

ASSUME SOURCE PRODUCES 50% SAND AND 50% FINE AGGR.

SAND REQUIRED $\frac{90,000 \times 751}{2000} = 33,795$ TONS

REDUCE COURSE AGGR $132,930 - 33,795 = 99,135$ TONS

COURSE AGGR. $\frac{99,135 \times 1.25}{(.5)(1.5)} = 165,220$ C.Y.

FINE AGGR. $\frac{67,590 \times 1.25}{(.7)(1.5)} = 80,460$ C.Y

TOTAL AMOUNT TO BE PROCESSED = 245,680 C.Y.

DETERMINATION OF CONTROLLING PLANT OR LABOR OUTPUT, AMOUNT OF CONTROLLING PLANT OR LABOR, OPERATIONAL SHIFTS AND SECONDARY PLANT REQUIRED TO ACCOMPLISH WORK IN AVAILABLE WORKING DAYS:

CLEARING AND GRUBBING @ 1000 $/ACRE × 10 ACRES = 10,000 $

ASSUME GRAVEL CAN BE EXCAVATED TO A DEPTH OF 21'

ASSUME DEPTH OF OVERBURDEN TO BE REMOVED IS 5'

USE PORTABLE CRUSHING PLANT (CAP. 200 TPH)

AT 70% EFFIC. $\frac{200 \times .7}{1.5} = 100$ C.Y/HR

TIME REQU. $\frac{245,680}{100} = 2,457$ HRS

AT 16 HRS/DAY $2457/16 = 153$ DAYS

SUMMARY OF OPERATIONAL TIME

SHIFTS PER DAY	HOURS PER SHIFT	PLANT HOURS	WORKING HOURS

REMARKS

ENG FORM 1741 (Translucent) (EM 1110-2-1302)

GOVERNMENT ESTIMATE WORK SHEET		SHEET 1 OF
PROJECT: SNETTISHAM		
SUBJECT: AGGREGATE SOURCE "B"		QUANTITY
AVAILABLE OPERATION TIME IN		
CALENDAR DAYS	WORKING DAYS	

PLAN OF OPERATIONS: HAUL AGGREGATES IN 20 CY DUMP TRUCKS FROM STOCKPILES TO BATCH PLANT OVER PERIOD OF TWO CONSTRUCTION SEASONS.

HAUL 115 %

COARSE AGGR. $\frac{99,135 \times 1.15}{1.15}$ = 76,000 C.Y.

FINE AGGR. $\frac{67,590 \times 1.15}{1.5}$ = 52,260 C.Y

TOTAL C.Y. TO BE HAULED 128,260 C.Y

HAULING DISTANCE IS ABOUT 3 MILES
ASSUME 1 TRIP/HR

TOTAL TRIPS 128,260/20 = 6413

AT 10 TRIPS/DAY AND 3 TRUCKS 642/3 = 214 DAYS

DETERMINATION OF CONTROLLING PLANT OR LABOR OUTPUT, AMOUNT OF CONTROLLING PLANT OR LABOR, OPERATIONAL SHIFTS AND SECONDARY PLANT REQUIRED TO ACCOMPLISH WORK IN AVAILABLE WORKING DAYS:

SUMMARY OF OPERATIONAL TIME

SHIFTS PER DAY	HOURS PER SHIFT	PLANT HOURS	WORKING HOURS

REMARKS

ENG FORM 11 (Formerly 993) (EM 1110 2 1302)

GOVERNMENT ESTIMATE WORK SHEET

SUBJECT: SNETTISHAM [illegible] "E"

QUANTITY:

PLANT

	UNIT OF PLANT	SIZE	NO.	HOURS*	RATE	AMOUNT
RENTAL OR OWNERSHIP EXPENSE	DOZER	100-150HP	1	1500	14.10	21,150
	DRAGLINE	1½ C.Y.	1	2457	28.40	67,779
	CRUSHING UNIT	200 T.P.H.	1	"	25.00	61,425
	DELIV. CONVEYOR	18" x 70'	1	"	8.90	21,867
	"	"	1	"	8.90	21,867
	PUMP	5"	1	"	2.00	4,914
	RESCREENING PLANT	5'x12'	1	"	6.10	14,988
	GATES, PIPES, BULKHEADS					5,000
	ROAD GRADER		1	1,230	14.00	17,220
				6M	1,259	7,554
OPERATING SUPPLIES AND FIELD REPAIRS	DUMP TRUCKS	20 CY	3	2,138.	26.50	169,945
	"		3	6M	2,037	36,666
	LOADING CONVEYOR		1	QUOTE		22,000
	PICK UP			3000	2.94	8,820
	"			6M	202	1,212
	FUEL TRUCK		1	1230	5.10	6,273
			1	6M	372	2,232

* NOTE: Use calender hours for plant rental and working hours for plant operating supplies and field repairs.

SUBTOTAL	492,912
SMALL TOOLS % OF LABOR	
TOTAL PLANT COST	

LABOR

OPERATION	CRAFT	NO.	HOURS**	RATE	AMOUNT
	DOZER OPERATOR	1	1500	5.86	8,790
	FOREMAN	1	2457	7.00	17,199
	DRAGLINE OPERATOR	1	"	6.42	15,774
	" OILER	1	"	5.34	13,120
	CRUSHER OPERATOR	1	"	5.97	14,668
	CRUSHER OILER	1	"	5.34	13,120
	FUEL TRUCK DRIVER	1	1230	5.47	6,728
	BELT OPERATOR	2	2457	5.34	26,240
	LABORER	2	2457	5.30	26,044
	DUMP TRUCK DRIVER	3	2138	5.84	37,452
	GRADER OPERATOR	1	1230	5.97	7,343
	MECHANIC	1	2457	5.97	14,668
			27,572		
TOTAL				SUBTOTAL	201,146
				OVERTIME 8.33 %	16,755
				SUBTOTAL	217,901
				COMP. & LIAB. INS., SOC. SEC. & STATE EMP. INS. 13.72 %	29,896
(** NOTE: USE WORKING HOURS)				TOTAL LABOR COST	247,797

ENG FORM 3741b (EM 1110-2-1302) (Translucent) REPLACES EDITION OF 1 MAY 60 WHICH MAY BE USED
1 AUG 62

GOVERNMENT ESTIMATE WORK SHEET

SUBJECT: SNETTISHAM AGGREGATE SOURCE "B"

QUANTITY

MATERIALS

DESCRIPTION	UNIT	QUANTITY	PRICE	AMOUNT
			TOTAL MATERIALS COST	

SUPPLIES

DESCRIPTION	UNIT	QUANTITY	PRICE	AMOUNT
			TOTAL SUPPLIES COST	

SUMMARY FOR TRANSFER TO ENG FORM NO. 1739 OR ENG FORM NO. 1740

PLANT	492,912
LABOR	247,797
MATERIALS	
SUPPLIES	
TOTAL	740,709

REMARKS: *Prices on these items are based on quotations from manufacturers or suppliers.

PREPARED BY G. GROESCHEL

CHECKED BY RB

ENG FORM 1 JAN 49 1741b (Translucent) (EM 1110-2-1302)

GOVERNMENT ESTIMATE WORK SHEET | SHEET 1 OF

PROJECT
Snettisham

SUBJECT
Aggregate Sources "C"

QUANTITY
85,215 cu. yd.

AVAILABLE OPERATION TIME IN

CALENDAR DAYS | WORKING DAYS

PLAN OF OPERATIONS: Source C is aggregate source of natural ledge rock immediately adjacent to [illegible] site.

Quantities required from total mix: Coarse Agg. 2954 #
Sand 751 #
3705 lb.

Req'd 90,000 cu. yd. conc.

90,000 × 3705 = 333,450,000 lb

Assume 15% production loss

333,450,000 ÷ .85 = 383,468,000 = 191,734 T

4500 lb granite = 1 cu. yd. in place measure

383,468 ÷ 4500 = 85,215 cu. yd.

Drill hours req'd $\frac{27V}{64R}$ $\frac{27(85,215)}{64(30)}$ = 1198 hrs. 8'×8' pattern, 30' feet per hour

Use 1200 hrs ÷ 16 hours day = 75 production days

Use 50% blasting time = .5 × 1200 = 600 hrs.

Total CORE TO BE DRILLED 36,000 FT

DETERMINATION OF CONTROLLING PLANT OR LABOR OUTPUT, AMOUNT OF CONTROLLING PLANT OR LABOR, OPERATIONAL SHIFTS AND SECONDARY PLANT REQUIRED TO ACCOMPLISH WORK IN AVAILABLE WORKING DAYS:

Using swell factor of 40% plant must be developed to handle 85,215 × 1.40 = 119,301 cu. yd.

BASE PRODUCTION CAPACITY OF PLANT ON 200 WORKING DAYS

$\frac{119,301}{200}$ = 597 CY/DAY

USE 100 CY/HR CAPACITY CRUSHING PLANT
@ 8 HRS DAY TOTAL OPERATING TIME IS 1600 HRS.

MOBILIZATION AND DEMOBILIZATION USE SAME COST AS FOR STUDY "C" 50,230 $

SUMMARY OF OPERATIONAL TIME

SHIFTS PER DAY	HOURS PER SHIFT	PLANT HOURS	WORKING HOURS

REMARKS

ENG FORM 1741 1 DEC 61 (Translucent) (EM 1110-2-1302)

GOVERNMENT ESTIMATE WORK SHEET

SUBJECT: Aggregate

QUANTITY: 75,215 cu yd

PLANT

	UNIT OF PLANT	SIZE	NO.	HOURS*	RATE	AMOUNT
RENTAL OR OWNERSHIP EXPENSE	Compressor	900 CFM	1	1200	9.55	11,460
	Air Trac	3½"	1	1200	7.22	8,664
	Powder Truck	2 Ton	1	600	1.57	942
OPERATING SUPPLIES AND FIELD REPAIRS	Compressor			1200	8.22	9864
	Air Trac			1200	2.10	2520
	Powder Truck			600	1.82	1092

*** NOTE:** *Use calendar hours for plant rental and working hours for plant operating supplies and field repairs.*

SUBTOTAL		34,542
SMALL TOOLS	% OF LABOR	
TOTAL PLANT COST		

LABOR

OPERATION	CRAFT	NO.	HOURS**	RATE	AMOUNT
	Compressor Operator	1	1200	5.61	6732
	Driller	1	1200	5.63	6756
	Chuck Tender	1	1200	5.36	6432
	Powder Man	1	600	5.76	3456
	Helper	1	600	5.13	3078

TOTAL	SUBTOTAL	26,454
OVERTIME 8.33 %		2,204
	SUBTOTAL	28,658
COMP. & LIAB. INS., SOC. SEC. & STATE EMP. INS. 13.72 %		3,932
(** NOTE: USE WORKING HOURS)	TOTAL LABOR COST	32,590

ENG FORM 1 AUG 62 1741a (EM 1110-2-1302) (Translucent) REPLACES EDITION OF 1 MAY 60 WHICH MAY BE USED

GOVERNMENT ESTIMATE WORK SHEET

SUBJECT	QUANTITY

PLANT

	UNIT OF PLANT	SIZE	NO.	HOURS*	RATE	AMOUNT
RENTAL OR OWNERSHIP EXPENSE	DOZER	100-150 HP	1	1600	14.10	22,500
	SHOVEL	1 CY.	1	"	27.70	44,320
	CRUSHING UNIT	200 T	1	"	25.00	40,000
	RESCREENING PLANT	5'x12'	1	"	6.10	9,760
	CONVEYOR	18" x 70'	1	"	7.80	12,480
	CONVEYOR					25,000
	FUEL TRUCK	1½ TON	1	"	5.10	8,160
	TRUCK	3/4 Ton	1	"	2.94	4,704
	PUMP	5"	1	"	2.00	3,200
	PRIMARY CRUSHER	24" x 36"	1	"	21.00	33,600
	GATES, PIPES, BULKHEADS					5,000
OPERATING SUPPLIES AND FIELD REPAIRS	DOZER		1	6 M	1370	8,220
	SHOVEL		1	"	2,440	14,640
	CRUSHING UNIT		1	"	3,800	22,800
	RESCREENING PLANT		1	"	1,000	6,000
	CONVEYOR		1	"	735	4,410
	FUEL TRUCK		1	"	372	2,232
	TRUCK	3/4 TON	1	"	202	1,212
	PUMP	5"	1	"	110	660
	PRIMARY CRUSHER	24"x36"	1	"	3,000	1,800
					SUBTOTAL	270,698
		SMALL TOOLS			% OF LABOR	
					TOTAL PLANT COST	

* NOTE: Use calendar hours for plant rental and working hours for plant operating supplies and field repairs.

LABOR

OPERATION	CRAFT	NO.	HOURS**	RATE	AMOUNT
	DOZER OPERATOR		1600	5.86	9,376
	SHOVEL OPERATOR		"	6.00	9,600
	" OILER		"	5.34	8,544
	CRUSHER OPERATOR	2	1600	5.97	19,104
	CRUSHER OILER	1	1600	5.34	8,544
	CONVEYOR OPERATOR	2	3200	5.34	17,088
	TRUCK DRIVER	1	1600	5.47	8,752
	LABORER	1	"	5.30	8,480
	FOREMAN	1	"	7.00	11,200
	TOTAL			SUBTOTAL	100,688
				OVERTIME 8.33 %	8,387
				SUBTOTAL	109,075
				COMP. & LIAB. INS., SOC. SEC. & STATE EMP. INS. 15.72 %	14,965
(** NOTE: USE WORKING HOURS)				TOTAL LABOR COST	124,040

GOVERNMENT ESTIMATE WORK SHEET

SUBJECT	QUANTITY
AGGREGATE SOURCE "C"	191,734 ton

MATERIALS

DESCRIPTION	UNIT	QUANTITY	PRICE	AMOUNT
POWDER				
.7#/Ton x 191,734	Lbs	134,214	.40	53,686
CAPS				
.7 ea. x 191,734	ea.	134,214	.28	37,580
DRILL STEEL				
1/20# / Ton 191,734 / 20	Lbs	9,587	.40	3,835
BITS .10/LF DRILLING	L.F.	36,000	.10	3,600
			TOTAL MATERIALS COST	98,701

SUPPLIES

DESCRIPTION	UNIT	QUANTITY	PRICE	AMOUNT
			TOTAL SUPPLIES COST	

SUMMARY FOR TRANSFER TO ENG FORM NO. 1739 OR ENG FORM NO. 1740

PLANT	305,240
LABOR	156,630
MATERIALS *	98,701
SUPPLIES	
TOTAL	560,571

REMARKS: *Prices on these items are based on quotations from manufacturers or suppliers.

PREPARED BY: G. GROSSCHEL

CHECKED BY: C. DRIVER

ENG FORM 1741b 1 JAN 49 (Translucent) (EM 1110-2-1302)

PART 6

LOG RECORDS - TEST PITS

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 94,140, E 95,470
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO.: FIELD TP-1, PERMANENT TP-1
- NAME OF DRILLER: Simon
- WEATHER: Raining
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO 1.0'; DEPTH DRILLED INTO 6.2'; TOTAL DEPTH OF HOLE 7.2'
- SIZE AND TYPE OF BIT: ½ yd. bucket
- DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL
- TYPE OF EQUIPMENT: Hyster backhoe on D-7 cat
- TOTAL NO. OF SAMPLES: 0
- TYPE OF SAMPLES:
- DEPTH TO GROUND WATER: 3.9'
- DATE HOLE STARTED: 28 Jun; COMPLETED: 28 Jun
- EL. TOP OF HOLE:
- Geologist: J. W. Knox
- Chief, Geology Section:
- Chief, Foundations & Materials Branch:
- Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–1		0		Sandy SILT	½"	Some organic material and clay, slightly plastic, brown. On margin of tidal flats between salt water and fresh water vegetation.
1–7.2				Sandy GRAVEL	18"	Some silt common cobbles and occasional boulders sub-rounded gravels chiefly metamorphic and igneous rocks. Water level fluctuates 1 to 2 feet with tides.

Note:
1. Location approximate, no survey control.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO. TP 1

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 94,240, E 95,320
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO.: FIELD TP-2, PERMANENT TP-2
- NAME OF DRILLER: Simon
- WEATHER: Rain
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO 4.8'; DEPTH DRILLED INTO 2.6'; TOTAL DEPTH OF HOLE 7.4'
- SIZE AND TYPE OF BIT: ½ yd. bucket
- DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL
- TYPE OF EQUIPMENT: Hyster backhoe on D-7 cat
- TOTAL NO. OF SAMPLES: 0
- TYPE OF SAMPLES:
- DEPTH TO GROUND WATER: 5.8'
- DATE HOLE STARTED: 28 Jun; COMPLETED: 28 Jun
- EL. TOP OF HOLE:
- Geologist: J. W. Knox
- Chief, Geology Section:
- Chief, Foundations & Materials Branch:
- Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–0.3				Organic SILT	1/8"	Brown to black, stream channel
0.3–4.8		0		SILT	8"	High organic content. Pea gravel common occasional cobbles gray black.
4.8–7.4				Silty SAND		Coarse pea gravel common occasional cobbles and boulders. Brown

Note:
1. Location approximate, no survey control.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO. TP-2

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 94,350, E 95,360
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO.: FIELD TP-3, PERMANENT TP-3
- NAME OF DRILLER: Simon
- WEATHER: Rain
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO; DEPTH DRILLED INTO; TOTAL DEPTH OF HOLE 7.1'
- SIZE AND TYPE OF BIT: ½ yd. bucket
- DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL
- TYPE OF EQUIPMENT: Hyster backhoe on D-7 cat
- TOTAL NO. OF SAMPLES: 0
- TYPE OF SAMPLES:
- DEPTH TO GROUND WATER: 5.4'
- DATE HOLE STARTED: 29 Jun; COMPLETED: 29 Jun
- EL. TOP OF HOLE:
- Geologist: J. W. Knox
- Chief, Geology Section:
- Chief, Foundations & Materials Branch:
- Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–1.2				Silty PEAT	.02'	Brown, largely organic along braided former stream channel.
1.2–2.1				Sandy SILT	1"	Some wood and gravel transitional zone
2.1–7.1		0		Sandy GRAVEL	2'	Cobbles increasing with depth; occasional boulders, coarse interstial silty sand. Gravel subrounded.
5.4				Water table		

Note:
1. Location approximate, no survey control.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO. TP-3

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 93,930, E 95,160
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO.: FIELD TP 23, PERMANENT TP 23
- NAME OF DRILLER: Wm. Burgess
- WEATHER: Rainy
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO; DEPTH DRILLED INTO; TOTAL DEPTH OF HOLE 6.5
- SIZE AND TYPE OF BIT: ½ yd. backhoe bucket
- DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL
- TYPE OF EQUIPMENT: Hyster backhoe D-7 cat
- TOTAL NO. OF SAMPLES: 1
- TYPE OF SAMPLES: Disturbed
- DEPTH TO GROUND WATER:
- DATE HOLE STARTED: 7 Oct; COMPLETED: 7 Oct
- EL. TOP OF HOLE:
- Geologist: J. W. Knox
- Chief, Geology Section:
- Chief, Foundations & Materials Branch:
- Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–1		0		Gravelly clayey SILT		Organic, plastic, gray brown, high moisture content.
1–6.5		1	GP NFS	Sandy GRAVEL	20"	with cobbles and occasional boulders. Brown intersticial sandy silt, some clay fines and organic matter. Zone from 1.0 - 1.3 rust stained.

NOTES: 1. Location approximate, no survey control.
2. Water levels vary with tides.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO. TP 23

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 94,210, E 95,220
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO.: FIELD TP 24, PERMANENT TP 24
- NAME OF DRILLER: Don Schill
- WEATHER: Rainy
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO 9.5; DEPTH DRILLED INTO; TOTAL DEPTH OF HOLE 9.5
- SIZE AND TYPE OF BIT: ½ yd backhoe bucket
- DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL
- TYPE OF EQUIPMENT: Hyster Backhoe D-7 Cat
- TOTAL NO. OF SAMPLES: 1
- TYPE OF SAMPLES: Disturbed
- DEPTH TO GROUND WATER:
- DATE HOLE STARTED: 7 Oct; COMPLETED: 7 Oct
- EL. TOP OF HOLE:
- Geologist: JW Knox-R Sperry
- Chief, Geology Section:
- Chief, Foundations & Materials Branch:
- Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–0.3				SILT		Brown, sphagnum moss
0.3–9.5		1		Sandy GRAVEL NFS		Cobbles and occasional boulders, organic matter limited to roots and rotted wood.

NOTE: 1. Location approximate, no survey control

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO. TP 24

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 93,800, E 95,070
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO.: FIELD TP 25, PERMANENT TP 25
- NAME OF DRILLER: Don Schill
- WEATHER: Rainy
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO; DEPTH DRILLED INTO; TOTAL DEPTH OF HOLE 9.0
- SIZE AND TYPE OF BIT: ½ yd. backhoe bucket
- DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL
- TYPE OF EQUIPMENT: Hyster backhoe D-7 cat
- TOTAL NO. OF SAMPLES: 1
- TYPE OF SAMPLES: Disturbed
- DEPTH TO GROUND WATER: 4.0
- DATE HOLE STARTED: 8 Oct; COMPLETED: 8 Oct
- EL. TOP OF HOLE:
- Geologist: R. Sperry
- Chief, Geology Section:
- Chief, Foundations & Materials Branch:
- Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–1		0		Gravelly SILT	2"	Organic brown
1–6		1	GP	Sandy GRAVEL NFS	21"	Some cobbles, and occasional boulders.
6–9		0				

NOTE: 1. Location approximate, no survey control.
2. Water level varies with tide.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO. TP 25

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION (Coordinates or Station): N 94,430 E 95,310
DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO.: FIELD TP-4 PERMANENT TP-4
NAME OF DRILLER: Simon — WEATHER: Rain
TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
DEPTH TO — DEPTH DRILLED INTO — TOTAL DEPTH OF HOLE: 4.0'
SIZE AND TYPE OF BIT: ½ yd. bucket
DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL
TYPE OF EQUIPMENT: Hyster backhoe on D-7 cat
TOTAL NO. OF SAMPLES: 0 — TYPE OF SAMPLES:
DEPTH TO GROUND WATER: — DATE HOLE STARTED: 29 Jun COMPLETED: 29 Jun
EL. TOP OF HOLE: — Geologist: J. W. Knox — Chief, Geology Section: — Chief, Foundations & Materials Branch: — Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1–2		0		Woody PEAT		Some interstitial sandy silt located on side of small 25' high hill. 60° slope frozen ground at 4'.
3				Silty SAND		Brown, organic inclusions
4				Gravelly SAND		Transition zone. Occasional cobble probable glacial till lateral moraine
						Note: 1. Location approximate, no survey control.

PROJECT: Snettisham — PERMANENT HOLE NO.: TP-4

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION (Coordinates or Station): N 94,050 E 95,240
DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO.: FIELD TP22 PERMANENT TP 22
NAME OF DRILLER: Wm. Burgess — WEATHER: Rainy
TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
DEPTH TO: 8.1 — DEPTH DRILLED INTO — TOTAL DEPTH OF HOLE: 8.1
SIZE AND TYPE OF BIT: ½ yd backhoe bucket
DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL
TYPE OF EQUIPMENT: Hyster Backhoe D-7 Cat
TOTAL NO. OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed
DEPTH TO GROUND WATER: — DATE HOLE STARTED: 7 Oct COMPLETED: 7 Oct
EL. TOP OF HOLE: — Geologist: J.W. Knox — Chief, Geology Section: — Chief, Foundations & Materials Branch: — Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1		0		Gravelly SILT		Organic, plastic, gray brown high moisture content.
2–4		0		Cobbley GRAVEL		With occasional boulders to 1.5'; interstitial gray brown silty sand.
5		1	GP	Sandy GRAVEL NFS	18"	Cobbles common, occasional boulders.
6–8		0		Sandy SILT W.T. 7.0'		With scattered gravel and cobbles, dark green gray, plastic
				NOTE: 1. Water Table varies with tides 2. Location approximate, no survey control		

PROJECT: Snettisham — PERMANENT HOLE NO.: TP 22

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION (Coordinates or Station): N 93,640 E 94,970
DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO.: FIELD TP 26 PERMANENT TP 26
NAME OF DRILLER: Don Schill — WEATHER: Rainy
TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
DEPTH TO — DEPTH DRILLED INTO — TOTAL DEPTH OF HOLE: 8.5
SIZE AND TYPE OF BIT: ½ yd. backhoe bucket
DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL
TYPE OF EQUIPMENT: Hyster backhoe D-7 cat.
TOTAL NO. OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed
DEPTH TO GROUND WATER: 3.0 — DATE HOLE STARTED: 8 Oct COMPLETED: 8 Oct
EL. TOP OF HOLE: — Geologist: R. Sperry — Chief, Geology Section: — Chief, Foundations & Materials Branch: — Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1		0		Sandy SILT	2mm	Organic plastic, gray brown.
2–8		1	GP	Sandy GRAVEL NFS	14"	Some cobbles and occasional boulders.
				NOTE: 1. Location approximate, no survey control.		

PROJECT: Snettisham — PERMANENT HOLE NO.: TP 26

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS
LOG RECORD NO. I

DESIGNED: Wm B Trautwein
DRAWN: Wm B Trautwein
CHECKED: D Hansen
PREPARED:
SUPERVISED: N A Dillon — CHIEF, GEOLOGY SECTION
SUBMITTED: [signature] — CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George — CHIEF, ENGINEERING DIVISION
APPROVED: Chas T Tailey — COLONEL, CE, DISTRICT ENGINEER
SCALE — DATE 20 Oct 65
FILE NUMBER
SHEET OF

2

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 93890 E 94650
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO: FIELD TP 27 PERMANENT TP 27
- NAME OF DRILLER: Don Schill — WEATHER: Rainy
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO: — DEPTH DRILLED INTO: — TOTAL DEPTH OF HOLE: 8.0
- SIZE AND TYPE OF BIT: ¼ yd. backhoe bucket — DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Hyster backhoe D-7 cat
- TOTAL NO OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: 0.7 — STARTED: 8 Oct — DATE HOLE COMPLETED: 8 Oct
- EL. TOP OF HOLE: — Geologist: R. Sperry — Chief, Geology Section: — Chief, Foundations & Materials Branch: — Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1.0		0		Gravelly SILT	3"	Organic, plastic, gray brown.
2.0						
3.0						
4.0						
5.0		1		Sandy GRAVEL	13"	Cobbles and occasional boulders.
6.0						
7.0						
8.0						

NOTES: 1. Water level varies with tides.
2. Location approximate, no survey control.
3. Field classification, no laboratory tests at this time.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 27

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 94200 E 94500
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO: FIELD TP 28 PERMANENT TP 28
- NAME OF DRILLER: Schill — WEATHER: Rainy
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO: — DEPTH DRILLED INTO: — TOTAL DEPTH OF HOLE: 9.5
- SIZE AND TYPE OF BIT: ¼ yd. backhoe bucket — DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Hyster backhoe D-7 cat
- TOTAL NO OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: 5.5 — STARTED: 8 Oct — DATE HOLE COMPLETED: 8 Oct
- EL. TOP OF HOLE: — Geologist: R. Sperry — Chief, Geology Section: — Chief, Foundations & Materials Branch: — Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
		0		Gravelly SILT		Organic, plastic, gray brown.
1.0						
2.0						
3.0		0		Cobbley GRAVELS	21"	Occasional boulders.
4.0						
5.0				W.T. Water flows through sand		
6.0		1		Gravelly SAND	6"	Occasional cobbles
7.0						
8.0						
9.0						
10.0						

NOTES: 1. Water level varies with tides.
2. Location approximate, no survey control.
3. Field classification, no laboratory tests at this time.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 28

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 94550 E 96030
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO: FIELD TP 29 PERMANENT TP 29
- NAME OF DRILLER: Schill — WEATHER: Rainy
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO: — DEPTH DRILLED INTO: — TOTAL DEPTH OF HOLE: 7.0
- SIZE AND TYPE OF BIT: ¼ yd. backhoe bucket — DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Hyster backhoe D-7 cat
- TOTAL NO OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: 0.8 — STARTED: 9 Oct — DATE HOLE COMPLETED: 9 Oct
- EL. TOP OF HOLE: — Geologist: R. Sperry — Chief, Geology Section: — Chief, Foundations & Materials Branch: — Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				SILT		Brown, organic, plastic, high moisture content.
1.0						WT 0.8
2.0						
3.0				Silty GRAVEL	13"	Cobbles and occasional boulders red interaticial sandy silt.
4.0						
5.0		1		Silty SAND	13"	
6.0						
7.0						

NOTES: 1. Water table varies with tides.
2. Location approximate, no survey control.
3. Field classification, no laboratory tests at this time.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 29

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 93650 E 92280
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO: FIELD TP 32 PERMANENT TP 32
- NAME OF DRILLER: Schill — WEATHER: Rainy
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO: — DEPTH DRILLED INTO: — TOTAL DEPTH OF HOLE: 12.5
- SIZE AND TYPE OF BIT: ¼ yd backhoe bucket — DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Hyster backhoe D-7 cat
- TOTAL NO OF SAMPLES: 0 — TYPE OF SAMPLES: — DEPTH TO GROUND WATER: 10.0 — STARTED: 12 Oct — DATE HOLE COMPLETED: 12 Oct
- EL. TOP OF HOLE: — Geologist: D. Lachel — Chief, Geology Section: — Chief, Foundations & Materials Branch: — Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1.0						
2.0						
3.0						
4.0						
5.0						
6.0		0		SANDY SILT		Plastic, blue gray, high moisture content, estuarine deposits.
7.0						
8.0						
9.0						
10.0						
11.0						
12.0						
12.5						

NOTE: 1. Location approximate, no survey control.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 32

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 92,430 E 91,600
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO: FIELD TP 33 PERMANENT TP 33
- NAME OF DRILLER: Schill — WEATHER: Rainy
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO: — DEPTH DRILLED INTO: — TOTAL DEPTH OF HOLE: 11.0
- SIZE AND TYPE OF BIT: ¼ yd. backhoe bucket — DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Hyster backhoe D-7 cat
- TOTAL NO OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: — STARTED: 25 Oct — DATE HOLE COMPLETED: 25 Oct
- EL. TOP OF HOLE: — Geologist: — Chief, Geology Section: — Chief, Foundations & Materials Branch: — Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				Sandy SILT		Plastic, dark bluish gray, organic.
1.0						
2.0						
3.0						
4.0						
5.0				Sandy GRAVEL	17"	Occasional boulders
6.0						
7.0						
8.0						
9.0						
10.0		1		Cobbley SAND		
11.0						

NOTE: 1. Location approximate, no survey control.
2. Surface water flowed into hole.

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 33

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

- PROJECT: Snettisham — SHEET 1 OF 1
- LOCATION (Coordinates or Station): N 92230 E 91020
- DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
- HOLE NO: FIELD TP 34 PERMANENT TP 34
- NAME OF DRILLER: Schill — WEATHER: Rain
- TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
- DEPTH TO: — DEPTH DRILLED INTO: — TOTAL DEPTH OF HOLE: 9.0'
- SIZE AND TYPE OF BIT: ¼ yd. backhoe bucket — DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Hyster backhoe D-7 cat
- TOTAL NO OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: 6.0 — STARTED: 25 Oct — DATE HOLE COMPLETED: 25 Oct
- EL. TOP OF HOLE: — Geologist: R. Velikanje — Chief, Geology Section: — Chief, Foundations & Materials Branch: — Date:

DEPTH FEET	% WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1.0						
2.0				SILT		Organic, plastic, dark bluish gray.
3.0						
4.0						
5.0						
6.0				Water table		25 Oct 1105
		1				
7.0				GRAVEL	15"	Cobbles and occasional boulders.
8.0						
9.0						

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 34

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
LOCATION (Coordinates or Station)	N 94,480 E 93,510
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO.	TP 30
PERMANENT	TP 30
NAME OF DRILLER	Schill
WEATHER	Rainy
TOTAL DEPTH OF HOLE	8.0
SIZE AND TYPE OF BIT	backhoe bucket
TYPE OF EQUIPMENT	Hyster backhoe D-7 cat
NO. OF SAMPLES	1
TYPE OF SAMPLES	Disturbed
DEPTH TO GROUND WATER	0.8
DATE HOLE STARTED	9 Oct
DATE HOLE COMPLETED	9 Oct
GEOLOGIST	R. Sperry

SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
			W.T. 0.8'
0	SILT		Plastic, high moisture content
0	Sandy GRAVEL	2"	Well graded
1	Gravelly SAND	3"	Well graded

NOTES: 1. Water table varies with tide.
2. Location approximate, no survey control.
3. Field classification, no laboratory test at this time.

PROJECT Snettisham PERMANENT HOLE NO. TP 30

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
LOCATION (Coordinates or Station)	N 94630 E [illegible]110
DRILLING AGENCY	CORPS OF ENGINEERS
FIELD HOLE NO.	TP 31
PERMANENT	TP 31
NAME OF DRILLER	Schill
WEATHER	Rainy
TOTAL DEPTH OF HOLE	13.0
SIZE AND TYPE OF BIT	½ yd backhoe bucket
TYPE OF EQUIPMENT	Hyster backhoe D-7 cat
TOTAL NO. OF SAMPLES	1
TYPE OF SAMPLES	Disturbed
DATE HOLE STARTED	10 Oct
DATE HOLE COMPLETED	10 Oct
GEOLOGIST	R. Sperry

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1.0–8.0	0	SILT		Organic, plastic, gray brown, high moisture content.
8.0–13.0	1	Gravelly SAND	23"	Cobbles and occasional boulders.

NOTES: 1. Location approximate, no survey control.
2. Field classification, no laboratory tests at at time.

PROJECT Snettisham PERMANENT HOLE NO. TP 31

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
LOCATION (Coordinates or Station)	N 90,910 E 90,270
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO.	TP 35
PERMANENT	TP 35
NAME OF DRILLER	Schill
WEATHER	Rainy
TOTAL DEPTH OF HOLE	10.0
SIZE AND TYPE OF BIT	yd Backhoe bucked
TYPE OF EQUIPMENT	Hyster Backhoe D-7 Cat
NO. OF SAMPLES	3
TYPE OF SAMPLES	Disturbed
DATE HOLE STARTED	25 Oct
DATE HOLE COMPLETED	25 Oct
GEOLOGIST	Lachel

SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0	Gravelly SILT	2"	Organic plastic, gray brown.
1	Gravelly SAND	12"	With cobbles and occasionally boulders
	W.T.		
2			

NOTE: 1. Location approximate, no survey control
2. Classified in field, no laboratory tests at this time.

PROJECT Snettisham PERMANENT HOLE NO. TP 35

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS
LOG RECORD NO. 2

DESIGNED: Wm. B. Trentwin
DRAWN: Wm. B. Trentwin
CHECKED: D. Hansen
PREPARED:
SUPERVISED: M. C. Dixon, CHIEF, GEOLOGY SECTION
SUBMITTED: [signature], CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George, CHIEF, ENGINEERING DIVISION
APPROVED: [signature], COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 6[illegible]
FILE NUMBER
SHEET OF

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION: N 90,640 E 90,180
DRILLING AGENCY: Corps of Engineers
HOLE NO.: FIELD TP 36 PERMANENT TP 36
NAME OF DRILLER: Schill — WEATHER: Rainy
TYPE OF HOLE: Test pit
TOTAL DEPTH OF HOLE: 10.0
SIZE AND TYPE OF BIT: ¼ yd backhoe bucket
TYPE OF EQUIPMENT: Hyster Backhoe D-7 Cat
TOTAL NO. OF SAMPLES: 2 — TYPE OF SAMPLES: Disturbed
DATE HOLE STARTED: 25 Oct — COMPLETED: 25 Oct
GEOLOGIST: JW Knox

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–1.0	0	SILT		Organic, plastic, gray brown
1.0–10.0	1, 2	Fine SAND & Gravelly SAND	25"	Cobbles and occasional boulders
3.0		W.T.		

NOTE: 1. Location approximate, no survey control.
2. Classified in field, no laboratory test at this time.

PROJECT Snettisham — PERMANENT HOLE NO TP 36

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION: N 90,350 E 90,400
DRILLING AGENCY: Corps of Engineers
HOLE NO.: FIELD TP 37 PERMANENT TP 37
NAME OF DRILLER: Schill — WEATHER: Rainy
TYPE OF HOLE: Test pit
TOTAL DEPTH OF HOLE: 12.0
SIZE AND TYPE OF BIT: ¼ yd backhoe bucket
TYPE OF EQUIPMENT: Hyster Backhoe D-7 Cat
TOTAL NO. OF SAMPLES: 3 — TYPE OF SAMPLES: Didturbed
DATE HOLE STARTED: 27 Oct — COMPLETED: 27 Oct
GEOLOGIST: Lachel

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–5.0	0, 1, 2	Silty SAND		Organic
2.0		W.T.		
4.0		W.T.		
5.0–12.0	3	Sandy GRAVEL		Cobbles and occasional boulders

NOTE: 1. Location approximate, no survey control
2. Classified in field, no laboratory tests at this time.

PROJECT Snettisham — PERMANENT HOLE NO TP 37

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION: N 90,550 E 90,530
DRILLING AGENCY: Corps of Engineers
HOLE NO.: FIELD TP 38 PERMANENT TP 38
NAME OF DRILLER: Schill — WEATHER: Rainy
TYPE OF HOLE: Test pit
TOTAL DEPTH OF HOLE: 14.0
SIZE AND TYPE OF BIT: ¼ yd backhoe bucket
TYPE OF EQUIPMENT: Hyster Backhoe D-7 Cat
TOTAL NO. OF SAMPLES: 2 — TYPE OF SAMPLES: Disturbed
DATE HOLE STARTED: 27 Oct — COMPLETED: 27 Oct
GEOLOGIST: JW Knox

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–1.0		Silty SAND		
1.0–3.0	0	SAND	6"	Occasional cobbles & boulders
3.0–5.0		Cobbley GRAVELL	12"	Occasional boulders
4.0		W.T.		
5.0–14.0	1, 2	SAND	10"	With silt, cobbles, occasional boulders

NOTE: 1. Location approximate, no survey control
2. Classified in field, no laboratory test at this time.

PROJECT Snettisham — PERMANENT HOLE NO TP 38

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION: N 90510 E 91070
DRILLING AGENCY: Corps of Engineers
HOLE NO.: FIELD TP 41 PERMANENT TP 41
NAME OF DRILLER: Schill — WEATHER: Rain
TYPE OF HOLE: Test pit
TOTAL DEPTH OF HOLE: 10.0'
SIZE AND TYPE OF BIT: ¼ yd. backhoe bucket
TYPE OF EQUIPMENT: Hyster backhoe D-7 cat
TOTAL NO. OF SAMPLES: 2 — TYPE OF SAMPLES: Disturbed
DATE HOLE STARTED: 28 Oct — COMPLETED: 28 Oct
GEOLOGIST: D. Lachel

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–3.0	1	Sandy GRAVEL	3"	
3.0		Water table 0900 hrs./28 Oct		
3.0–5.0	2	SILT		
5.0–10.0		Sandy GRAVEL	10"	Cobbles

Note: 1. Location approximate, no survey control.
2. Classified in field, no laboratory test at this time.

PROJECT Snettisham — PERMANENT HOLE NO TP 41

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION: N 90,830 E 91,180
DRILLING AGENCY: Corps of Engineers
HOLE NO.: FIELD TP 42 PERMANENT TP 42
NAME OF DRILLER: Schill — WEATHER: Rainy
TYPE OF HOLE: Test pit
TOTAL DEPTH OF HOLE: 14.0
SIZE AND TYPE OF BIT: ¼ Yd backhoe bucket
TYPE OF EQUIPMENT: Hyster Backhoe D-7 Cat
TOTAL NO. OF SAMPLES: 2 — TYPE OF SAMPLES: Disturbed
DATE HOLE STARTED: 28 Oct — COMPLETED: 28 Oct
GEOLOGIST: JW Knox

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–8.0	0	SILT		Organic Plastic, bluish gray
8.0–10.0		GRAVEL		
10.0–12.0	1	Sandy GRAVEL		Some clay
12.0–14.0	2	SAND		

NOTE: 1. Location approximate, no survey control.
2. Classified in field, no laboratory tests at this time

PROJECT Snettisham — PERMANENT HOLE NO TP 42

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 2
LOCATION: N 91,090 E 90,930
DRILLING AGENCY: Corps of Engineers
HOLE NO.: FIELD TP 43 PERMANENT TP 43
NAME OF DRILLER: SCHILL — WEATHER: Rainy
TYPE OF HOLE: Test pit
TOTAL DEPTH OF HOLE: 15.0
SIZE AND TYPE OF BIT: ¼ yd backhoe bucket
TYPE OF EQUIPMENT: Hyster Backhoe D-7 Cat
TOTAL NO. OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed
DATE HOLE STARTED: 28 Oct — COMPLETED: 28 Oct
GEOLOGIST: JW Knox

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–12.0	0	Sandy SILT		
12.0		W.T. 12.0'		
12.0–14.0	1	SAND		Some Cobbles

PROJECT Snettisham — PERMANENT HOLE NO TP 43

[... OF] THE ARMY / [... PA]CIFIC DIVISION / [... ENGINEE]R DISTRICT, ALASKA / [EXPLORAT]ION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 90940, E 90670
Drilling agency	Corps of Engineers
Permanent hole no.	TP 39
Name of driller	Don Schill
Weather	Rain
Total depth of hole	12.0'
Size and type of bit	[...] bucket
Type of equipment	Hyster backhoe D-7 Cat
Type of samples	Disturbed
Depth to ground water	0.4'
Started	27 Oct
Date hole completed	27 Oct
Geologist	[...] W. Knox

Classification	Max size particle	Formation description & remarks
Gravelly, SILT	2"	Organic, plastic, bluish gray
GRAVEL	3"	Reddish brown, with cobbles.
SILT	1mm	
GRAVEL	10"	with cobbles and occasional boulders.

NOTE: 1. Location approximate, no survey control.
2. Classified in field, no laboratory test at this time.

PROJECT Snettisham PERMANENT HOLE NO. TP 39

DEPARTMENT OF THE ARMY / NORTH PACIFIC DIVISION / U.S. ARMY ENGINEER DISTRICT, ALASKA / EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 90,280, E 90,720
Drilling agency	Corps of Engineers
Field hole no.	TP 40
Permanent hole no.	TP 40
Name of driller	Schill
Weather	Rainy
Type of hole	Test pit
Total depth of hole	12.0
Size and type of bit	½ yd backhoe bucket
Type of equipment	Hyster Backhoe D-7 Cat
Total no. of samples	2
Type of samples	Disturbed
Started	27 Oct
Date hole completed	27 Oct
Geologist	JW Knox

Depth feet	Sample no.	Classification	Max size particle	Formation description & remarks
0–1.0	0	SAND		With organic silt, roots
1.0–12.0	1, 2	Sandy GRAVEL (W.T. at 2.0)	24"	With cobbles and boulders

NOTE: 1. Location approximate, no survey control
2. Classified in field, no laboratory tests at this time.

NPD FORM 19 (REV) DEC 1959

PROJECT Snettisham PERMANENT HOLE NO. TP 40

[... OF] THE ARMY / [... PA]CIFIC DIVISION / [... ENGINEE]R DISTRICT, ALASKA / [EXPLORAT]ION LOG

Project	Snettisham
Sheet	2 of 2
Location	N 91,090, E 90,930
Drilling agency	Corps of Engineers
Permanent hole no.	TP 43
Name of driller	Schill
Weather	Rainy
Total depth of hole	15.0
Type of equipment	Hyster Backhoe D-7 Cat
Type of samples	Disturbed
Started	28 Oct
Date hole completed	28Oct

NOTE: 1. Location approximate, no survey control
2. Classified in field, no laboratory tests at this time

PROJECT Snettisham PERMANENT HOLE NO. TP 43

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm E. Trautwein
DRAWN: Wm E. Trautwein
CHECKED: D. Hanser
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS
LOG RECORD NO. 3

SUPERVISED: M A Dixon, CHIEF, GEOLOGY SECTION
SUBMITTED: Robert F. Jones, CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George, CHIEF, ENGINEERING DIVISION
APPROVED: Clare F. Farley, COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

2

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 2
Location: N 90,860 E 91,500
Drilling agency: Corps of Engineers
Hole No.: Field TP 44, Permanent TP 44
Name of driller: Schill — Weather: Rainy
Type of hole: Test pit — Total depth of hole: 15.0
Size and type of bit: ½ yd backhoe bucket — Type of equipment: Hyster Backhoe D-7 Cat
Total no. of samples: 1 — Type of samples: Disturbed — Started: 28 Oct — Completed: 28Oct
Geologist: JW Knox

Depth feet	Sample no.	Classification	Formation description & remarks
		SILT	Organic, Plastic, dark blue
5.0	0		
10.0		W.T. 10.0'	
		Gravelly SAND	Some cobbles
11.0	1		

NPA Form Dec 1959 (Rev) — Project: Snettisham — Permanent Hole No.: TP44

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 2 of 2
Location: N 90,860 E 91,500
Drilling agency: Corps of Engineers
Hole No.: Field TP 44, Permanent TP 44
Name of driller: Schill — Weather: Rainy
Type of hole: Test pit — Total depth of hole: 15.0
Size and type of bit: ½ yd backhoe bucket — Type of equipment: Hyster Backhoe D-7 Cat
Total no. of samples: 1 — Type of samples: Disturbed — Started: 28 Oct — Completed: 28 Oct
Geologist: JW Knox

Depth feet	Classification	Formation description & remarks
	Gravelly SAND	
15.0		

NOTE: 1. Location approximate, no survey control
2. Classified in field, no laboratory tests at this time

NPA Form Dec 1959 (Rev) — Project: Snettisham — Permanent Hole No.: TP 44

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 90,280 E 91,020
Drilling agency: Corps of Engineers
Hole No.: Field TP 45, Permanent TP 45
Name of driller: Schill — Weather: Rainy
Type of hole: Test pit — Total depth of hole: 6.0
Size and type of bit: ½ yd backhoe bucket — Type of equipment: Hyster Backhoe D-7 Cat
Total no. of samples: 1 — Type of samples: Disturbed — Started: 28 Oct — Completed: 28 Oct
Geologist: JW Knox

Depth feet	Sample no.	Classification	Formation description & remarks
		SILT	Blue gray, plastic, organic
2.0	1		
6.0			

NOTE: 1. Location approximate, no survey control

NPA Form Dec 1959 (Rev) — Project: Snettisham — Permanent Hole No.: TP 45

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 90,450 E 91,350
Drilling agency: Corps of Engineers
Hole No.: Field TP 48, Permanent TP 48
Name of driller: Hogan — Weather: Rain & Snow
Type of hole: Test pit — Total depth of hole: 10.0
Size and type of bit: ½ yd backhoe bucket — Type of equipment: Hyster Backhoe D-7 Cat
Type of samples: Disturbed — Started: 7 Nov — Completed: 7 Nov
Geologist: Lachel

Depth feet	Sample no.	Classification	Formation description & remarks
		SILT	Bluish gray, plastic, some sand, organic, marine
2.0	0		
4.0		Sandy GRAVEL	Cobbles common, well rounded chiefly Qtz Diorite, some Basalt
5.0		W.T.	
9.0	1		
10.0			

NOTE: 1. Location approximate, no survey control.
2. Classified in field, no laboratory tests at this time.

NPA Form Dec 1959 (Rev) — Project: Snettisham — Permanent Hole No.: TP48

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 90,450 E 91,060
Drilling agency: Corps of Engineers
Hole No.: Field TP 49, Permanent TP 49
Name of driller: Hogan — Weather: Rain & Snow
Type of hole: Test pit — Total depth of hole: 12.0
Size and type of bit: ½ yd backhoe bucket — Type of equipment: Hyster Backhoe D-7 Cat
Total no. of samples: 1 — Type of samples: Disturbed — Started: 7 Nov — Completed: 7 Nov
Geologist: Lachel

Depth feet	Sample no.	Classification	Formation description & remarks
		SILT	Plastic, organic, marine, blue gray
3.0	0		
6.0		Silty Gravelly SAND	Coarse grained, angular, well rounded gravels, Qtz Diorite, some Basalt.
7.0		W.T.	
9.0	1	Silty Sandy GRAVEL	Well rounded and graded
12.0			

NOTE: 1. Location approximate, no survey control.
2. Classified in field, no laboratory tests at this time.

NPA Form Dec 1959 (Rev) — Project: Snettisham — Permanent Hole No.: TP 49

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 2
Location: N 91,180 E 90,790
Drilling agency: Corps of Engineers
Hole No.: Field TP 50, Permanent TP 50
Name of driller: Hogan — Weather: Rain & Snow
Type of hole: Test pit — Total depth of hole: 16.0
Size and type of bit: ½ yd backhoe bucket — Type of equipment: Hyster Backhoe D-7 Cat
Total no. of samples: 0 — Started: 7 Nov — Completed: 7 Nov
Geologist: Lachel

Depth feet	Classification	Formation description & remarks
	SILT	Organic plastic, marine, blue gray.
10.0	W.T.	

NPA Form Dec 1959 (Rev) — Project: Snettisham — Permanent Hole No.: TP 50

U. S. ARMY

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
LOCATION (Coordinates or Station)	N 90010 E 90850
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO. FIELD	TP 46
PERMANENT	TP 46
NAME OF DRILLER	Schill
WEATHER	Rainy
TOTAL DEPTH OF HOLE	10.0
SIZE AND TYPE OF BIT	backhoe bucket
TYPE OF EQUIPMENT	Hyster backhoe D-7 Cat
TOTAL NO. OF SAMPLES	1
TYPE OF SAMPLES	Disturbed
DEPTH TO GROUND WATER	2.0
DATE HOLE STARTED	28 Oct
COMPLETED	28 Oct
GEOLOGIST	D. Lachel

SAMPLE NO.	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
	Silty SAND		Organic material.
0	Sandy GRAVEL		Cobbles and occasional boulder
		18"	
1			

NOTE: 1. Location approximate, no survey control.
2. Classified in field, no laboratory test at this time.

PROJECT Snettisham PERMANENT HOLE NO. TP 46

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
LOCATION (Coordinates or Station)	N 90060 E 91040
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO. FIELD	TP 47
PERMANENT	TP 47
TYPE OF HOLE	TEST PIT
NAME OF DRILLER	Hogan
WEATHER	Cloudy rainy
TOTAL DEPTH OF HOLE	10.0
SIZE AND TYPE OF BIT	½ yd backhoe bucket
TYPE OF EQUIPMENT	Hyster backhoe D-7 Cat
TOTAL NO. OF SAMPLES	1
TYPE OF SAMPLES	Disturbed
DATE HOLE STARTED	6 Nov
COMPLETED	6 Nov
GEOLOGIST	D. Lachel

DEPTH FEET	WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–8				Silty SAND		Very few boulders and cobbles, many roots.
8–10		1		Silty Sandy GRAVEL		cobbles common, all material well rounded large boulders at 10.0'

NOTES: 1. Location approximate, no survey control.
2. Classified in field, no laboratory test at this time.
3. Water table not reached, but hole filled by tidal water.

NPA FORM 19 (REV) DEC 1958

PROJECT Snettisham PERMANENT HOLE NO. TP 47

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	2 OF 2
LOCATION (Coordinates or Station)	N 91,180 E 90,790
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO.	TP 50
PERMANENT	TP 50
NAME OF DRILLER	Hogan
WEATHER	Rain and Snow
TOTAL DEPTH OF HOLE	16.0
SIZE AND TYPE OF BIT	backhoe bucket
TYPE OF EQUIPMENT	Hyster Backhoe D-7 Cat
DATE HOLE STARTED	7 Nov
COMPLETED	7 Nov
GEOLOGIST	Lachel

CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
SILT	

NOTE: 1. Location approximate, no survey control.

PROJECT Snettisham PERMANENT HOLE NO. TP 50

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm B. Trautwein
DRAWN: Wm B. Trautwein
CHECKED: D. Hansen
PREPARED:
CHIEF

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS
LOG RECORD NO. 4

SUPERVISED: N. A. Dixon
CHIEF, GEOLOGY SECTION
SUBMITTED:
CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George
CHIEF, ENGINEERING DIVISION

APPROVED: Clare F. Farley
COLONEL, CE, DISTRICT ENGINEER

SCALE
DATE 20 Apr 65
FILE NUMBER
SHEET OF

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 91,320 E 90,590
Drilling Agency	Corps of Engineers
Hole No. Field	TP 51
Permanent	TP 51
Name of Driller	Hogan
Weather	Rain & Snow
Type of Hole	Test Pit
Total Depth of Hole	12.0
Size and Type of Bit	½ yd backhoe bucket
Type of Equipment	Hyster Backhoe D-7 Cat
Total No. of Samples	1
Type of Samples	Disturbed
Started	7 Nov
Date Hole Completed	7 Nov
Geologist	JW Knox

Depth Feet	Sample No.	Classification	Max Size Particle	Formation Description & Remarks
1.0		SILT		Organic, plastic, marine blue gray
3.0	0			
4.0		Silty Sandy GRAVEL		Well rounded and graded, chiefly Qtz Diorite. Gravel increasees with depth.
6.0		W.T.		
8.0–9.0	1			
12.0				

NOTE: 1. Location approximate, no survey control.
2. Classified in field, no laboratory tests at this time.

NPA FORM 19 (REV) DEC 1959 — PROJECT Snettisham — PERMANENT HOLE NO. TP 51

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 91,180 E 90,270
Drilling Agency	Corps of Engineers
Hole No. Field	TP 52
Permanent	TP 52
Name of Driller	Hogan
Weather	Rain & Snow
Type of Hole	Test Pit
Total Depth of Hole	10.0
Size and Type of Bit	½ yd backhoe bucket
Type of Equipment	Hyster Backhoe D-7 Cat
Total No. of Samples	1
Type of Samples	Disturbed
Started	7 Nov
Date Hole Completed	7 Nov
Geologist	Lachel

Depth Feet	Sample No.	Classification	Max Size Particle	Formation Description & Remarks
0–1.0		SILT		Blue gray, plastic, organic, marine
3.0		Silty Sandy GRAVEL	3"	Well rounded, iron stained red
3.0		Gravelly SAND	5"	Well rounded
4.0	0	W.T.		
5.0–6.0		Sandy GRAVEL	5"	Rounded and well graded in all sizes
8.0–9.0	1			
10.0				

NOTE: 1. Location approximate, no survey control.
2. Classification in field, no laboratory tests at this time.

NPA FORM 19 (REV) DEC 1959 — PROJECT Snettisham — PERMANENT HOLE NO. TP 52

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 91,060 E 90,060
Drilling Agency	Corps of Engineers
Hole No. Field	TP 53
Permanent	TP 53
Name of Driller	Hogan
Weather	Rain & Snow
Type of Hole	Test Pit
Total Depth of Hole	10.0
Size and Type of Bit	½ yd backhoe bucket
Type of Equipment	Hyster Backhoe D-7 Cat
Total No. of Samples	1
Type of Samples	Disturbed
Started	7 Nov
Date Hole Completed	7 Nov
Geologist	Lachel

Depth Feet	Sample No.	Classification	Max Size Particle	Formation Description & Remarks
0–1.0		SILT		Bluish grey, plastic, organic marine.
2.0–3.0	0	Sandy GRAVEL		Well graded in all sizes, well rounded, much rust staining on rock, predominantly Qtz Diorite.
3.0		W.T.		
8.0–9.0	1			
10.0				

NOTE: 1. Location Approximate, no survey control
2. Classified in field, no laboratory tests to this time.

NPA FORM 19 (REV) DEC 1959 — PROJECT Snettisham — PERMANENT HOLE NO. TP 53

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 93,540 E 95,160
Drilling Agency	Corps of Engineers
Hole No. Field	TP 56
Permanent	TP 56
Name of Driller	Hogan
Weather	Cloudy
Type of Hole	Test Pit
Total Depth of Hole	7.0
Size and Type of Bit	½ yd. backhoe bucket
Type of Equipment	Hyster backhoe D-7 cat
Total No. of Samples	2
Type of Samples	Disturbed
Started	11 Nov
Date Hole Completed	11 Nov
Geologist	Velikanje

Depth Feet	Sample No.	Classification	Max Size Particle	Formation Description & Remarks
0–1.0	0	Silty GRAVEL	8"	Organics, marine, blue gray
1.0		Silty GRAVEL		Red
2.0–3.0		Water table tide level 1125 hrs. Note: water rose in pit as tide fell.		
3.0	1	Sandy GRAVEL	6"	Some silt
5.0–6.0	2	Gravelly SAND		Much contamination from upper strata-hole caving from sides.
6.0–7.0		Gravelly SAND		Some silt, blue gray, pieces of wood, some rusty pods.
7.0				

Note: 1. Location approximate, no survey control.
2. Field classification, no laboratory tests at this time.

NPA FORM 19 (REV) DEC 1959 — PROJECT Snettisham — PERMANENT HOLE NO. TP 56

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 94,700 E 95,150
Drilling Agency	Corps of Engineers
Hole No. Field	TP 57
Permanent	TP 57
Name of Driller	Hogan
Weather	Rain
Type of Hole	Test Pit
Total Depth of Hole	11.4
Size and Type of Bit	½ yd backhoe bucket
Type of Equipment	Hyster Backhoe D-7 Cat
Total No. of Samples	2
Type of Samples	Disturbed
Started	14 Nov
Date Hole Completed	14 Nov
Geologist	JW Knox

Depth Feet	Sample No.	Classification	Max Size Particle	Formation Description & Remarks
0–1.0	0	PEAT		Organic, silty some gravel, tree roots, moss and rotting logs.
1.0–2.0	1	Silty Sandy GRAVEL	8"	Organic, dark brown, cobbles common, old wood, subrounded gravels and cobbles
6.0–7.0	2	GRAVEL	38"	Subrounded, coarse, silty, interstial sand, brown, cobbles common, occasional boulders.
11.0	0			
11.4				

NOTE: 1. Location approximate, no survey control
2. Classified in field, no laboratory tests at this time.

NPA FORM 19 (REV) DEC 1959 — PROJECT Snettisham — PERMANENT HOLE NO. TP 57

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 95,040 E 95,140
Drilling Agency	Corps of Engineers
Hole No. Field	TP 58
Permanent	TP 58
Name of Driller	Hogan
Weather	Rain
Type of Hole	Test Pit
Total Depth of Hole	11.0
Size and Type of Bit	½ yd backhoe bucket
Type of Equipment	Hyster Backhoe D-7 Cat
Total No. of Samples	3
Type of Samples	Disturbed
Started	14 Nov
Date Hole Completed	14 Nov
Geologist	JW Knox

Depth Feet	Sample No.	Classification	Max Size Particle	Formation Description & Remarks
0		Silty GRAVEL		Organic moss, thin top soil
1.0–2.0		Sandy Cobbley GRAVEL		Occasional boulders, well graded, some silt, subrounded, principally Qtz Diorite, occasional Basalt and Qtz cobbles and pebbles.
3.0	1			
4.0				Water seeping in at 4.5'
5.0–6.0	2	Sandy GRAVEL	2.0'	Cobbles common, occasional boulders, moist, well graded, subrounded
9.0	0	Cobbley Sandy GRAVEL	2.0'	Boulders
10.0	3			
11.0				

NOTE: 1. Location approximate, no survey control
2. Classified in field, no laboratory tests at this time.

NPA FORM 19 (REV) DEC 1959 — PROJECT Snettisham — PERMANENT HOLE NO. TP 58

...MENT OF THE ARMY
...PACIFIC DIVISION
...ENGINEER DISTRICT, ALASKA
...ORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 90,670 E 89,670
Drilling agency	Corps of Engineers
Permanent hole no.	TP 54
Name of driller	Hogan
Weather	Rain & Snow
Total depth of hole	9.0
Size and type of bit	... bucket
Type of equipment	Hyster Backhoe D-7 Cat
Type of samples	Disturbed
Date hole started	7 Nov
Completed	7 Nov
Geologist	... Lachel

Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		Silty SAND		
1		Sandy GRAVEL	30"	Well graded and rounded. Numerous cobbles and boulders many logs beneath surface, predominantly Qtz Diorite, some Basalt.
		W.T.		

NOTE: 1. Location approximate, no survey control
2. Classified in field, no laboratory tests at this time

PROJECT Snettisham PERMANENT HOLE NO. TP 54

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 91,710 E 90,840
Drilling agency	Corps of Engineers
Hole no.	Field TP 55, Permanent TP 55
Name of driller	Hogan
Weather	Rain and snow
Type of hole	Test pit
Total depth of hole	11.0
Size and type of bit	1yd. backhoe bucket
Type of equipment	Hyster backhoe D-7 Cat
Total no. of samples	1
Type of samples	Disturbed
Depth to ground water	n.r.
Date hole started	9 Nov
Completed	9 Nov
Geologist	D. Lachel

Depth feet	% water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
1.0						
2.0						
3.0				SILT		Bluish gray, organic marine, not as plastic as similar material from area.
4.0		1				
5.0						
6.0				Sandy SILT		Bluish gray, fine-medium grained sand.
7.0						
8.0				Silty SAND		
				Silty Sandy GRAVEL	1"	
9.0						
10.0				Silty Sandy GRAVEL	6"	Few cobbles, predominantly quartz diorite.
11.0						

Notes: 1. Location approximate, no survey control.
2. Field classification, no laboratory tests at this time.

NPD FORM 55 (REV) DEC 1959

PROJECT Snettisham PERMANENT HOLE NO. TP 55

...MENT OF THE ARMY
...PACIFIC DIVISION
...ENGINEER DISTRICT, ALASKA
...ORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 95,320 E 94,790
Drilling agency	Corps of Engineers
Permanent hole no.	TP 59
Name of driller	Hogan
Weather	Rain
Total depth of hole	8.0
Size and type of bit	... Bucket
Type of equipment	Hyster Backhoe D-7 Cat
Date hole started	14 Nov
Completed	14 Nov
Geologist	... Lachel

Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		PEAT	18"	Organic material, roots, moss some cobbles and boulders on surface.
...0		Cobbley SAND	36"	Occasional boulders, all material well rounded Qtz Diorete, few Basalt cobbles.
		Silty SAND W.T.	20"	Dark brown, fine to med grained, sand, one clay seam to 1.0 foot. Few cobbles and boulders much organic material

NOTE: 1. Location approximate, no survey control.
*2. Classified in field, no laboratory tests at this time.

PROJECT Snettisham PERMANENT HOLE NO. TP 59

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm. B. Trautwein
DRAWN: Wm. B. Trautwein
CHECKED: D. Hansen
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS

LOG RECORD NO. 5

SUPERVISED: M. B. Dixon, CHIEF, GEOLOGY SECTION
APPROVED: Clay T. Farley, COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: CHIEF, FOUNDATIONS & MATERIALS BRANCH
SCALE
DATE 20 Oct 65
FILE NUMBER
RECOMMENDED: Harry Geng. CHIEF, ENGINEERING DIVISION
SHEET OF

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: Snettisham — **Sheet** 1 of 1
Location: N 95,750 E 95,000 — Drilling Agency: Corps of Engineers
Hole No.: Field TP 60, Permanent TP 60 — **Name of Driller:** Hogan — **Weather:** Rain & Snow
Type of Hole: Test Pit — **Total Depth of Hole:** 5.0
Size and Type of Bit: ¾ yd backhoe bucket — **Type of Equipment:** Hyster Backhoe D-7 Cat
Total No. of Samples: 1 — **Type of Samples:** Disturbed — **Date Hole Started:** 16 Nov — **Completed:** 16 Nov
Geologist: Dr Knox

Depth Feet	Sample No.	Soil Legend	Classification	Max Size Particle	Formation Description & Remarks
0–2.0	1	GP	Sandy GRAVEL NFS	25"	Numerous cobbles, occasional boulders, well graded, some silt, rounded.
2.0–5.0			Sandy Gravelly COBBLES W.T.	36"	Boulders more plentiful than above, subrounded composition as above

NOTE: 1. Location approximate, no survey control.

NPA Form Dec 1959 (Rev) — PROJECT Snettisham — PERMANENT HOLE NO TP 60

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: SNETTISHAM — **Sheet** 1 of 1
Location: N 96,070 E 94,980 — Drilling Agency: Corps of Engineers
Hole No.: Field TP-61, Permanent TP-61 — **Name of Driller:** Hogan — **Weather:** Cloudy
Type of Hole: Test Pit
Size and Type of Bit: ¾yd Backhoe Bucket — **Type of Equipment:** Hyster Backhoe D-7 Cat
Total No. of Samples: 3 — **Type of Samples:** Disturbed — **Date Hole Started:** 16 Nov — **Completed:** 16 Nov
Geologist: Lachel

Depth Feet	Sample No.	Soil Legend	Classification	Max Size Particle	Formation Description & Remarks
0–4	1		Gravelly Sandy COBBLES (W.T. 3.5)	18"	Few boulders, well rounded. Fine to coarse grained sand. Quartz Diorite predominant.
4–8	2		Sandy Gravelly COBBLES	15"	Cobbles generally smaller than above, averaging 6-7". Higher percent of gravel fewer boulders, material subrounded.
8–13	3		Sandy Cobbley GRAVEL	12"	Well graded gravel, few boulders, well rounded. Many logs and organic material at 8' level indicating former surface area. Small chunks of silty sand.

NOTES: 1. Location approximate, no survey control.

NPA Form Dec 1959 (Rev) — PROJECT SNETTISHAM — PERMANENT HOLE NO TP-61

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: SNETTISHAM — **Sheet** 1 of 1
Location: N 94,100 E 94,580 — Drilling Agency: Corps of Engineers
Hole No.: Field TP-62, Permanent TP-62 — **Name of Driller:** Hogan — **Weather:** Rainy
Type of Hole: Test Pit
Size and Type of Bit: ¾ yd Backhoe Bucket — **Type of Equipment:** Hyster Backhoe D-7 Cat
Total No. of Samples: 1 — **Type of Samples:** Distrubed — **Date Hole Started:** 17 Nov — **Completed:** 17 Nov
Geologist: J. W. Knox

Depth Feet	Sample No.	Soil Legend	Classification	Max Size Particle	Formation Description & Remarks
0–10	1		Bouldery GRAVEL		Subrounded boulders to 40". Med coarse grained sand, small amounts of silt. Digging somewhat easier below 6.0', but still many boulders. Refusal Due to boulders.

NOTE: 1. Location approximate, no survey control.
2. Field classification, no laboratory tests at this time.

NPA Form Dec 1959 (Rev) — PROJECT SNETTISHAM — PERMANENT HOLE NO TP-62

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: SNETTISHAM — **Sheet** 1 of 1
Location: N 94,690 E 95,310 — Drilling Agency: Corps of Engineers
Hole No.: Field TP-69, Permanent TP-69 — **Name of Driller:** O'Brien & Huzarski — **Weather:** Sunny - Warm
Type of Hole: Test Pit — **Total Depth of Hole:** 6.5
Size and Type of Bit: Pick and shovel — **Type of Equipment:** Pick & Shovel
Total No. of Samples: None — **Type of Samples:** None — **Depth to Ground Water:** -- — **Date Hole Started:** 24 June — **Completed:** 24 June
Geologist: Lachel

Depth Feet	Sample No.	Soil Legend	Classification	Max Size Particle	Formation Description & Remarks
0–3.5			PEAT		Brown to Black, Slightly Plastic, Impervious
3.5–4.0			Sandy PEAT		Black to Brown, Fine Grained Sand
4.0–4.5			Peaty SAND		Fine Grained, Rust Stained Weathered Zone
4.5–6.5			SAND		Fine Grained, Tan, Small Amounts of Black Mineral, Well Drained.

NOTE: (1) Water Table not reached, perched water hole approx 10 ft North, 2 ft deep - no water in test pit.
(2) Location approx, no survey control.

NPA Form Dec 1959 (Rev) — PROJECT SNETTISHAM - LOWER CAMP SITE — PERMANENT HOLE NO TP-69

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: SNETTISHAM — **Sheet** 1 of 1
Location: N 94,860 E 95,370 — Drilling Agency: Corps of Engineers
Hole No.: Field TP-70, Permanent TP-70 — **Name of Driller:** O'Brien & Huzarski — **Weather:** Clear - warm
Type of Hole: Test Pit — **Total Depth of Hole:** 6.0
Size and Type of Bit: Hand dug — **Type of Equipment:** Pick and shovel
Total No. of Samples: None — **Type of Samples:** None — **Date Hole Started:** 24 June 65 — **Completed:** 25 June 65
Geologist: Lachel

Depth Feet	Sample No.	Soil Legend	Classification	Max Size Particle	Formation Description & Remarks
0–2.5			PEAT		Brown to black impervious.
2.5–4.0			Sandy PEAT		Brown, medium to coarse grained sand.
4.0–4.5			Slightly Peaty SAND		Fine-medium grained, rust stained.
4.5–6.0			Slightly gravelly SAND	1"	Fine to coarse grained sand well washed, clean, tan.

NOTE: (1) Water table not reached, perched water table in peat; pond 3 ft deep, 15 ft east of test pit.
(2) Location approx, no survey control.

NPA Form Dec 1959 (Rev) — PROJECT SNETTISHAM - LOWER CAMP SITE — PERMANENT HOLE NO TP 70

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: SNETTISHAM — **Sheet** 1 of 1
Location: N 94,985 E 95,360 — Drilling Agency: Corps of Engineers
Hole No.: Field TP-71, Permanent TP-71 — **Name of Driller:** Richmond — **Weather:** Clear and sunny
Type of Hole: Test Pit — **Depth to:** 5.0 — **Total Depth of Hole:** 5.0
Size and Type of Bit: Hand Dug — **Type of Equipment:** Pick and Shovel
Total No. of Samples: None — **Date Hole Started:** 25 June 65 — **Completed:** 25 June 65
Geologist: Lachel

Depth Feet	Sample No.	Soil Legend	Classification	Max Size Particle	Formation Description & Remarks
0–2.0			PEAT		Brown to black, soft, saturated, woody.
2.0–3.5			Slightly Sandy PEAT		Med to coarse grained sand, impervious.
3.5–5.0			Peaty SAND		Fine to med grained, impervious, small amounts of gravel to 4" in diam.

NOTE: (1) Water from perched table in peat trickled into pit from source 6 inches below surface and stood in bottom.
(2) Location approx, no survey control.

NPA Form Dec 1959 (Rev) — PROJECT SNETTISHAM - LOWER CAMP SITE — PERMANENT HOLE NO TP-71

THE ARMY
DIVISION
STRICT, ALASKA
LOG

PROJECT: SNETTISHAM — SHEET 1 OF 2
LOCATION (Coordinates or Station): N 94,550 E 95,290
DRILLING AGENCY: OTHER Contractor - W. T. Grant
PERMANENT HOLE NO.: TP-63
NAME OF DRILLER: W. T. Grant
WEATHER: Rainy
TOTAL DEPTH OF HOLE: 21'
TYPE OF EQUIPMENT: Backhoe
NO. OF SAMPLES: 1
CLASSIFIED BY: N. Dixon

CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
PEAT		Organic, silty, black & brown. 1' to 4' thickness
Gravelly SAND	3"	Coarse, tan, occasional pebbles. Pea gravel common, layered structure common, cross bedded. 2' to 10' thickness. Beds dip towards Speel Arm.
Sandy GRAVEL	6"	Cobbles, well graded. 3'+ thickness.
Gravelly SAND	2"	2'+ thickness.
Sandy GRAVEL		Rust stained. 1'+ thickness.
Gravelly SAND	6"	Coarse, cobbles to 2' - 15'+ thickness.

PROJECT: SNETTISHAM — PERMANENT HOLE NO.: TP-63

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: SNETTISHAM — SHEET 2 OF 2
LOCATION (Coordinates or Station): N 94,550 E 95,290
DRILLING AGENCY: OTHER Contractor, W. T. Grant
FIELD HOLE NO.: Contractors — PERMANENT: TP-63
WEATHER: Rainy
TYPE OF HOLE: Borrow pit
TOTAL DEPTH OF HOLE: 21'
SIZE AND TYPE OF BIT: None
TYPE OF EQUIPMENT: Backhoe
TOTAL NO. OF SAMPLES: 4
TYPE OF SAMPLES: Soil
GEOLOGIST: J. W. Knox
CLASSIFIED BY: N. Dixon

DEPTH FEET	WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				SAND		Coarse, with scattered pebbles, occasional cobbles.
15						
					6"	2-15'+ thickness of cross bedded sand.
16						
17		4				
18						
19						
20						
						This pit is located just North of the new camp area.

NOTE:
1. Location approximate, no survey control.
2. Field classification, no laboratory tests at this time.
3. Contractor's gravel and sand pit, 60' wide, 100' long, 20' deep.

NPA FORM 1232 (REV)

PROJECT: SNETTISHAM — PERMANENT HOLE NO.: TP-63

THE ARMY
DIVISION
STRICT, ALASKA
LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1
LOCATION (Coordinates or Station): N 95,290 E 95,330
DRILLING AGENCY: CORPS OF ENGINEERS
PERMANENT HOLE NO.: TP-72
NAME OF DRILLER: O'Brien & Huzarski
WEATHER: Clear & Sunny
TOTAL DEPTH OF HOLE: 5.2
TYPE OF EQUIPMENT: Pick and Shovel
DEPTH TO GROUND WATER: -
STARTED: 25 June 65 — DATE HOLE COMPLETED: 25 June 65

CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
PEAT		Dark brown, soft, saturated.
Peaty SAND		Brown, medium grained.
SAND		Limonite, rust stained, fine grained.
Sandy GRAVEL		Coarse grained, cobbles and boulders.

ter table not reached.
cation approx, no survey control.

PROJECT: SNETTISHAM - LOWER CAMP SITE — PERMANENT HOLE NO.: TP-72

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm B Trautwein
DRAWN: Wm B Trautwein
CHECKED: D. Hansen
PREPARED:
CHIEF

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS
LOG RECORDS NO. 6

SUPERVISED: N. E. Dixon — CHIEF, GEOLOGY SECTION
SUBMITTED: Roland B. [illegible] — CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George — CHIEF, ENGINEERING DIVISION
APPROVED: Clare F. Farley — COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

2

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: SNETTISHAM — Hole No. TP-73 — Driller: O'Brien & Richmond — Weather: Partly cloudy — Hand dug, Pick & shovel — Samples: None

Classification	Formation description & remarks
PEAT	Brown, saturated, occasional boulders in base of peat to 18"
Gravelly SAND	Limonite rust staining, medium to coarse grained.
Cobbly SAND and GRAVEL 12"	Well graded, sand fine to coarse grained.

NOTE: (1) Water table not reached - perched water table in numerous ponds in peat nearby. (2) Location approximate, no survey control.

PROJECT SNETTISHAM - UPPER CAMP SITE — PERMANENT HOLE NO. TP-73

Project: SNETTISHAM — Hole No. TP-76 — Driller: O'Brien, Richmond — Weather: Light & rain — Hand dug, Pick and shovel — Samples: None

Classification	Formation description & remarks
PEAT	Saturated, brown, impervious
Gravelly SAND	Limonite rust staining, med grained
Cobbley Sandy GRAVEL 10"	Well graded and rounded in all sizes, occasional boulders.

NOTE: Water table not reached - perched water table in peat. Numerous ponds in area to 3 ft deep.

PROJECT SNETTISHAM - UPPER CAMP SITE — PERMANENT HOLE NO. TP-76

Project: SNETTISHAM - POWERHOUSE — Hole No. TP-81 — Driller: O'Brien — Weather: Cloudy — Pick and shovel — Samples: None

Classification	Formation description & remarks
SILT	Organic soil, many roots, moss, peaty texture.
Boulders	
Bedrock	Dug and blasted 2 ft ± of overburden and boulders to expose a sloping quartz diorite bedrock over 6'x8'. Strike of bedrock surface N 47°E, Dip 30°SE. The same type bedrock is exposed ±30' NW with a rock face showing the same dip and strike as in the test pit.

NOTE: Location approximate, no survey control.

PROJECT SNETTISHAM — PERMANENT HOLE NO. TP-81

Project: SNETTISHAM — Hole No. TP-83 — Driller: Simon — Weather: Partly cloudy — 1 yd Backhoe, Hyster Backhoe - D-7 Cat — Samples: None — Date: 25 July 63 – 25 July 63 — Geologist: Hansen

Classification	Formation description & remarks
Sandy SILT	Gray, fine sand with organic matter.
Gravelly SAND	Reddish brown gravel, limonite stain - fine to med grained, occasional cobbles and boulders.
Gravelly SAND	Gray, fine to med grained sand, occasional boulders & cobbles.

PROJECT SNETTISHAM — PERMANENT HOLE NO. TP-83

Project: SNETTISHAM — Hole No. TP-86 — Driller: Simon — 1 yd Backhoe, Hyster Backhoe - D-7 Cat — Samples: None — Date: 25 July 63 – 25 July 63 — Geologist: Hansen

Classification	Formation description & remarks
Sandy SILT	Dark gray, organic matter.
SILT, SAND	Red brown some gravel - high limonite staining
SAND	Slightly gravelly gray - fine to med grained.

PROJECT SNETTISHAM — PERMANENT HOLE NO. TP-86

Project: SNETTISHAM — Hole No. TP-87 — Driller: Simon — Weather: Partly cloudy — Hyster Backhoe - D-7 Cat — Samples: None — Date: 26 Jul 63 – 26 Jul 63 — Geologist: Hansen

Classification	Formation description & remarks
Sandy Gravelly PEAT	Dark brown
Silty Sandy GRAVEL	High limonite staining partially cemented, brown with cobbles and boulders.
SAND	Gray fine to med grained, occasional cobbles and boulders.
SAND	Fine to coarse, gray, gravel

PROJECT SNETTISHAM — PERMANENT HOLE NO. TP-87

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 94,230 E 94,015
Drilling agency: Corps of Engineers
Hole No.: TP-83 Permanent: TP-83
Name of driller: Simon Weather: Partly cloudy
Depth drilled into: 9.0' Total depth of hole: 9.0'
Type of equipment: Cat Hyster Backhoe
Type of samples: -
Date hole started: 24 Jul 65 Completed: 24 Jul 65
Geologist: Hansen

Classification	Max size particle	Formation description & remarks
Sandy SILT		Gray, fine with organic matter.
Gravelly SAND	4"	Brown, fine to coarse, limonite stained.

9.0 feet - Bottom of Hole

Project: SNETTISHAM Permanent hole No.: TP-83

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 94,266 E 94,330
Drilling agency: Corps of Engineers
Hole No.: TP-84 Permanent: TP-84
Name of driller: Simon Weather: Partly cloudy
Type of hole: Test pit
Depth drilled into: 6.5' Total depth of hole: 6.5'
Size and type of bit: Backhoe
Type of equipment: Cat Hyster Backhoe
Total no. of samples: None Type of samples: --
Date hole started: 24 Jul 65 Completed: 24 Jul 65
Geologist: Hansen

Depth feet	Classification	Formation description & remarks
	Sandy SILT	Gray, fine, with organic matter.
2.5	Fine SAND	Brown and gray, portions highly stained with limonite.

6.5 feet - Bottom of Hole

Project: SNETTISHAM Permanent hole No.: TP-84

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 94,620 E 93,735
Drilling agency: Corps of Engineers
Hole No.: TP-88 Permanent: TP-88
Name of driller: Simon Weather: Clear
Depth drilled into: 10.0' Total depth of hole: 10.0'
Size and type of bit: backhoe
Type of equipment: Hyster Backhoe D-7 Cat
Type of samples: --
Date hole started: 26 Jul 65 Completed: 26 Jul 1965
Geologist: Hansen

Classification	Formation description & remarks
PEAT	Brown
Silty SAND	Brown, heavy limonite staining.
SAND	Gray, varved.
CLAY	Gray

Project: SNETTISHAM Permanent hole No.: TP-88

Revision	Date	Description	By

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

Designed: Wm B. Trautwein
Drawn: Wm B. Trautwein
Checked: D Hansen
Prepared:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS
LOG RECORDS NO. 7

Supervised: M A Dixon, Chief, Geology Section
Submitted: Roland B Yaws, Chief, Foundations & Materials Branch
Recommended: Warren George, Chief, Engineering Division
Approved: Clare F Farley, Colonel, CE, District Engineer
Scale: Date: 20 Oct 65
File Number:
Sheet of

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location (Coordinates or Station): N 93,930 E 94,792
Drilling Agency: Corps of Engineers
Hole No.: Field TP-89, Permanent TP-89
Name of Driller: Simon — Weather: Clear
Type of Hole: Test Pit
Size and Type of Bit: ½ yd Backhoe
Type of Equipment: Hyster Backhoe - D-7 Cat
Total No. of Samples: None — Type of Samples: --
Date Hole: Started 28 Jul 1965, Completed 28 Jul 65
Geologist: Hansen

Depth Feet	Classification	Formation Description & Remarks
	Hole flooded - must be de-watered.	

Project SNETTISHAM — Permanent Hole No. TP-89

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location (Coordinates or Station): N 94,143 E 94,730
Drilling Agency: Corps of Engineers
Hole No.: Field TP-90, Permanent TP-90
Name of Driller: Simon — Weather: Clear
Type of Hole: Test Pit
Depth Drilled into: 13.0' — Total Depth of Hole: 13.0'
Size and Type of Bit: ½ yd Backhoe Bucket
Type of Equipment: Hyster Backhoe D-7 Cat
Total No. of Samples: None
Date Hole: Started 28 Jul 65, Completed 28 Jul 65
Geologist: Hansen

Depth Feet	Classification	Formation Description & Remarks
0–7	PEAT	Dark brown
7–8	Sandy GRAVEL	Red brown, high limonite staining.
8–13	Sandy GRAVEL	Tan, cobbles and boulders limonite stained.

Project SNETTISHAM — Permanent Hole No. TP-90

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location (Coordinates or Station): N 94,600 E 94,040
Drilling Agency: Corps of Engineers
Hole No.: Field TP-91, Permanent TP-91
Name of Driller: Simon — Weather: Clear
Type of Hole: Test Pit
Depth Drilled into: 10.0' — Total Depth of Hole: 10.0'
Size and Type of Bit: ½ Yd. Backhoe
Type of Equipment: Hyster Backhoe - D-7 Cat
Total No. of Samples: None — Type of Samples: --
Date Hole: Started 28 Jul 65, Completed 28 Jul 65
Geologist: Hansen

Depth Feet	Classification	Formation Description & Remarks
0–0.6	PEAT	Dark brown, forest litter.
0.6–5.5	Gravelly SAND	Brown, highly limonite stained.
5.5–10	Gravelly SAND	Gray, slightly stained 3" minus

Project SNETTISHAM — Permanent Hole No. TP-91

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location (Coordinates or Station): N E
Drilling Agency: Corps of Engineers
Hole No.: Field TP-95, Permanent TP-95
Name of Driller: Simon — Weather: Cloudy
Type of Hole: Test Pit
Total Depth of Hole: 7.0'
Size and Type of Bit: ½ yd backhoe bucket
Type of Equipment: Hyster backhoe D-7 Cat
Total No. of Samples: None — Type of Samples: ---
Depth to Ground Water: 4.5
Geologist: Binkley

Depth Feet	Classification	Formation Description & Remarks
0–3.5	SILT & Sandy SILT	Grass roots.
3.5–4.5	SAND	Silty to clean medium grained.
4.5 (W.T.)–7.0	SAND	Clean, gray, medium to coarse grained, free running below water table.

NOTE: Location: Speel River flats est 2500' east of camp.

Project SNETTISHAM — Permanent Hole No. TP-95

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location (Coordinates or Station): N E
Drilling Agency: Corps of Engineers
Hole No.: Field TP-96, Permanent TP-96
Name of Driller: SIMON — Weather: Cloudy
Type of Hole: Test Pit
Total Depth of Hole: 7.0
Size and Type of Bit: ½ yd Backhoe Bucket
Type of Equipment: Hyster Backhoe D-7 Cat
Total No. of Samples: None
Depth to Ground Water: 4.5
Date Hole: Started 2 Aug 1965, Completed 2 Aug 1965
Geologist: Binkley

Depth Feet	Classification	Formation Description & Remarks
0–3.5	SILT	Some silty fine sand, grass roots common.
3.5–4.5	SAND	Medium grained, gray Water table 4.5'
4.5–7.0	SAND	Medium grained, free running below water table.

NOTE: Location:: Speel River flats est 3500', east of camp.

Project SNETTISHAM — Permanent Hole No. TP 96

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 2
Location (Coordinates or Station): N 94,550 E 94,300
Drilling Agency: Corps of Engineers
Hole No.: Field TP-97, Permanent TP-97
Name of Driller: Simon — Weather: Clear
Type of Hole: Test Pit
Total Depth of Hole: 18.0
Size and Type of Bit: ½ yd Backhoe Bucket
Type of Equipment: Hyster Backhoe - D-7 Cat
Total No. of Samples: None
Date Hole: Started 3 Aug 65, Completed 3 Aug 65
Geologist: Binkley

Depth Feet	Classification	Formation Description & Remarks
0–2.0	PEAT	Dark brown, organic soil and forest litter.
2.0–5.5	Gravelly SAND	3" minus, high limonite staining.
5.5–8.5	SAND	Some gravel to 3", sand coarse, sharp, clean, gray with faint limonite stain.
8.5–9.8	Sandy GRAVEL	Gravel approx 60% to 3" sharp sand, lenses from 0.5' to 2.0'
9.8–11.5	Gravelly SAND	Sand gray approx. 90% gravel (10%) to 3".
11.5–12.8	Sandy GRAVEL	Sand (40%) gravel, to 3" (60%) lenses from 0.4' to 1.8'
12.8–14.0	SAND	Gray, with a few pockets and lenses of 3" - gravel.

Project SNETTISHAM — Permanent Hole No. TP-97

DEP…
TP-97
16.0
18.0

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1
LOCATION (Coordinates or Station): N — E —
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO.: TP-93 — PERMANENT: TP-93
NAME OF DRILLER: Simon
TYPE OF HOLE: TEST PIT
TOTAL DEPTH OF HOLE: 6.0
SIZE AND TYPE OF BIT: yd backhoe bucket
TYPE OF EQUIPMENT: Hyster backhoe, D-7 Cat
TOTAL NO. OF SAMPLES: None — TYPE OF SAMPLES: ---
DEPTH TO GROUND WATER: 4.0
DATE HOLE STARTED: 2 Aug 65 — COMPLETED: 2 Aug 65
Geologist: Binkley

CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
Sandy SILT	Med gray, grassroots.
SAND W.T.	Medium to coarse grained several silty sand streaks to 2", loose uncompacted flowing sand below water table.

NOTES:
1. Location: Speel River flats, est 500' east of camp.
2. No survey control.

PROJECT: SNETTISHAM — PERMANENT HOLE NO.: TP-93

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1
LOCATION (Coordinates or Station): N — E —
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO.: FIELD TP-94 — PERMANENT: TP-94
NAME OF DRILLER: Simon — WEATHER: ...udy
TYPE OF HOLE: TEST PIT
TOTAL DEPTH OF HOLE: 6.0
SIZE AND TYPE OF BIT: ½ yd backhoe bucket
TYPE OF EQUIPMENT: Hyster backhoe D-7 Cat
TOTAL NO. OF SAMPLES: None — TYPE OF SAMPLES: --
DEPTH TO GROUND WATER: 3.5'
DATE HOLE STARTED: 2 Aug 65 — COMPLETED: 2 Aug 65
Geologist: Binkley

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
	Silty SAND & sandy SILT	Grass roots.
2.0	Silty SAND W.T.	Fine to medium grained, digs easily.
4.0	SAND	Medium to coarse grained free runing under water. No silt streaks noted, caves as fast as it is dug.
6.0		

NOTE: Location: Speel River Flats, est 1500' east of camp.

PROJECT: SNETTISHAM — PERMANENT HOLE NO.: TP-94

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: SNETTISHAM — SHEET 2 OF 2
LOCATION (Coordinates or Station): N 94,550 — E 94,300
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO.: TP-97 — PERMANENT: TP-97
NAME OF DRILLER: SIMON — WEATHER: Clear
TOTAL DEPTH OF HOLE: 18.0
SIZE AND TYPE OF BIT: Backhoe Bucket
TYPE OF EQUIPMENT: Hyster Backhoe - D-7 Cat
DATE HOLE STARTED: 3 Aug 65 — COMPLETED: 3 Aug 65
Geologist: Binkley

CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
SAND	

PROJECT: SNETTISHAM — PERMANENT HOLE NO.: TP-97

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS
LOG RECORDS NO. 8

DESIGNED: Wm. B. Trautwein
DRAWN: Wm. B. Trautwein
CHECKED: D. Hansen
PREPARED:
SUPERVISED: N. A. Dixon — CHIEF, GEOLOGY SECTION
SUBMITTED: — CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Harry George — CHIEF, ENGINEERING DIVISION
APPROVED: Clare F. Farley — COLONEL, CE, DISTRICT ENGINEER
SCALE — DATE 20 Oct 65
FILE NUMBER
SHEET — OF

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 2

Drilling agency: Corps of Engineers

Hole No.: Field TP-98; Permanent TP-98

Name of driller: SIMON

Weather: Partly Cloudy

Total depth of hole: 22'

Size and type of bit: ½ yd. Backhoe Bucket

Type of equipment: Hyster Backhoe - D-7 Cat

Total no. of samples: None

Depth to ground water: -

Date hole started: 9 Aug 1965; completed: 9 Aug 1965

Hansen

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
				PEAT	Brown
2.0					
4.0				Gravelly SAND	Brown limonite stained.
6.0					
8.0					
10.0				Gravelly SAND	Gray, fine to medium grained sand, 2" minus less than 10%.
12.0				Gravelly SAND	Gray, medium to coarse sand, 4" minus. Gravel 20 - 25%
14.0					

Project: SNETTISHAM — Permanent Hole No.: TP-98

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

Project: SNETTISHAM — Sheet 2 of 2

Drilling agency: Corps of Engineers

Hole No.: Field TP-98

Name of driller: SIMON

Weather: Partly Cloudy

Total depth of hole: 22'

Size and type of bit: ½ yd. Backhoe Bucket

Type of equipment: Hyster Backhoe - D-7 Cat

Total no. of samples: None

Depth to ground water: --

Date hole started: 9 Aug 65; completed: 9 Aug 65

Hansen

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
16.0				Gravelly SAND	
18.0					
20.0					
22.0					
24.0					
26.0					
28.0					

Project: SNETTISHAM — Permanent Hole No.: TP-98

U. S. ARMY

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm B. Trautwein
DRAWN: Wm B. Trautwein
CHECKED: D Hansen
PREPARED:
CHIEF

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS

LOG RECORDS NO. 9

SUPERVISED: [signature] CHIEF, GEOLOGY SECTION
SUBMITTED: [signature] CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George CHIEF, ENGINEERING DIVISION
APPROVED: [signature] COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct. 65
FILE NUMBER
SHEET OF

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Hole No.: Field LLTP 1 — Permanent TP 5
Drilling agency: Corps of Engineers
Name of driller: Nielsen and Caskey — Weather: Rainy
Type of hole: Test pit — Total depth of hole: 2.5
Type of equipment: Pick and shovel
Total no. of samples: 1 — Type of samples: Disturbed
Depth to ground water: 0.9' — Started: 14 Sep — Completed: 14 Sep
El. top of hole: 813.7 — Geologist: R. Sperry

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
1.0				SAND		Water table varies with lake level
2.0		1	SP-SM	Gravelly SAND		Some organic material such as twigs and branches in sample.

Note: 1. Location approximate, no survey control.

Temporary designation LLTP 1

Project: Snettisham — Permanent hole no.: TP 5

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Hole No.: Field LLTP 2 — Permanent TP 6
Drilling agency: Corps of Engineers
Name of driller: Nielsen and Caskey — Weather: Rainy
Total depth of hole: 2.0
Type of equipment: Pick and shovel
Depth to ground water: 0.9
El. top of hole: 814.0 — Geologist: R. Sperry

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
1.0				Water table		
				SAND		Some pebbles
2.0						

Notes: 1. Location approximate, no survey control.

Temporary Designation LLTP 2

Project: Snettisham — Permanent hole no.: TP 6

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Hole No.: Field LLTP 3 — Permanent TP 7
Drilling agency: Corps of Engineers
Name of driller: Nielsen and Caskey — Weather: Rainy
Total depth of hole: 2.0
Type of equipment: Pick and shovel
Depth to ground water: 1.0 — Started: 14 Sep — Completed: 14 Sep
El. top of hole: 814.4 — Geologist: R. Sperry

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
1.0				Water table		
				Sandy GRAVEL	2"	
2.0						

Notes: 1. Location approximate, no survey control.

Temporary designation LLTP 3

Project: Snettisham — Permanent hole no.: TP 7

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Hole No.: Field LLTP 6 — Permanent TP 10
Drilling agency: Corps of Engineers
Name of driller: Caskey and Nielsen — Weather: Rainy
Type of hole: Test pit — Total depth of hole: 1.8
Type of equipment: Pick and shovel
Total no. of samples: 1
Depth to ground water: 1.4 — Started: 14 Sep — Completed: 14 Sep
El. top of hole: 817.0 — Geologist: R. Sperry

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
1.0		1	GP	Sandy GRAVEL	3"	
2.0						

Note: 1. Location approximate, no survey control.

Temporary designation LLTP 6

Project: Snettisham — Permanent hole no.: TP 10

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Hole No.: Field LLTP 7 — Permanent TP 11
Drilling agency: Corps of Engineers
Name of driller: Nielsen and Caskey — Weather: Rainy
Type of hole: Test pit — Total depth of hole: 2.2
Type of equipment: Pick and shovel
Depth to ground water: 1.9 — Started: 14 Sep — Completed: 14 Sep
El. top of hole: 816.2 — Geologist: R. Sperry

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
				Silty SAND	5"	
1.0						
				Sandy GRAVEL Water table		
2.0						

Notes: 1. Location approximate, no survey control.

Temporary designation LLTP 7

Project: Snettisham — Permanent hole no.: TP 11

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Hole No.: Field LLTP 8 — Permanent TP 12
Drilling agency: Corps of Engineers
Name of driller: Nielsen and Caskey — Weather: Rainy
Type of hole: Test pit — Total depth of hole: 2.3
Type of equipment: Pick and shovel
Depth to ground water: 1.9 — Started: 14 Sep — Completed: 14 Sep
El. top of hole: 816.0 — Geologist: R. Sperry

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
				Silty SAND		
1.0				Sandy GRAVEL	2"	
				Water table		
2.0						

Note: 1. Location approximate, no survey control.

Temporary designation LLTP 8

Project: Snettisham — Permanent hole no.: TP 12

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
HOLE NO. FIELD	LLTP 4
HOLE NO. PERMANENT	TP 8
NAME OF DRILLER	Nielsen and Caskey
TYPE OF HOLE	TEST PIT
TOTAL DEPTH OF HOLE	2.0
TYPE OF EQUIPMENT	Pick and shovel
DEPTH TO GROUND WATER	1.0
EL. TOP OF HOLE	813.5
GEOLOGIST	R. Sperry

DEPTH FEET	WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				Water table		
1.0				Sandy GRAVEL	6"	

Note: 1. Location approximate, no survey control.

Temporary designation LLTP 4

NPA FORM 1959 (REV)

PROJECT Snettisham PERMANENT HOLE NO. TP 8

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
HOLE NO. FIELD	LLTP 5
HOLE NO. PERMANENT	TP 9
NAME OF DRILLER	Nielsen & Caskey
WEATHER	Rainy
TYPE OF HOLE	TEST PIT
DEPTH TO	3.0
TOTAL DEPTH OF HOLE	3.0
SIZE AND TYPE OF BIT	Hand dug
TYPE OF EQUIPMENT	Pick & Shovel
TOTAL NO. OF SAMPLES	1
TYPE OF SAMPLES	Disturbed
DEPTH TO GROUND WATER	2.6
DATE HOLE STARTED	14 Sep 64
DATE HOLE COMPLETED	14 Sep
GEOLOGIST	R. Sperry

DEPTH FEET	WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
		1		Sandy GRAVEL	3"	
1.0						
2.0						
3.0						

Approximate location, no survey control

NPA FORM 1959 (REV)

PROJECT Snettisham PERMANENT HOLE NO. TP 9

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
HOLE NO. FIELD	LLTP 9
HOLE NO. PERMANENT	TP 13
NAME OF DRILLER	Caskey and Nielsen
WEATHER	Rainy
TYPE OF HOLE	TEST PIT
TOTAL DEPTH OF HOLE	2.6
DATUM FOR ELEVATION SHOWN	MSL
TYPE OF EQUIPMENT	Pick and shovel
TOTAL NO. OF SAMPLES	2
TYPE OF SAMPLES	Disturbed
DEPTH TO GROUND WATER	2.5
DATE HOLE STARTED	14 Sep
DATE HOLE COMPLETED	14 Sep
EL. TOP OF HOLE	819.0
GEOLOGIST	R. Sperry

DEPTH FEET	WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
			SP-SM	Silty SAND		
1.0			GP	Sandy GRAVEL		
2.0				Water table		
3.0						

Note: 1. Location approximate, no survey control.

Temporary designation LLTP 9

NPA FORM 1959 (REV)

PROJECT Snettisham PERMANENT HOLE NO. TP 13

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE ALASKA

DESIGNED: Wm. B. Trautwein
DRAWN: Wm. B. Trautwein
CHECKED: D. Hansen
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS
LOG RECORD NO. 10

SUPERVISED: M. Dixon CHIEF, GEOLOGY SECTION
SUBMITTED: Robert B. Jones CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George CHIEF, ENGINEERING DIVISION
APPROVED: Clare T. Farley COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION (Coordinates or Station): N E
DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO.: FIELD LLTP 10 — PERMANENT TP 14
NAME OF DRILLER: Caskey and Nielsen — WEATHER: Rainy
TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
TOTAL DEPTH OF HOLE: 2.3
DATUM FOR ELEVATION SHOWN: [ ] TBM [X] MSL — TYPE OF EQUIPMENT: Pick and shovel
TOTAL NO. OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: 2.1 — DATE HOLE STARTED: 14 Sep — COMPLETED: 14 Sep
EL. TOP OF HOLE: 819.6 — Geologist: R. Sperry

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1.0		1	SP	Gravelly SAND	3"	
2.0				Water table		
				Note: 1. Location approximate, no survey control.		
				Temporary designation LLTP 10		

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 14

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION (Coordinates or Station): N E
DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO.: FIELD LLTP 11 — PERMANENT TP 15
NAME OF DRILLER: Caskey and Nielsen — WEATHER: Rainy
TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
TOTAL DEPTH OF HOLE: 1.1
DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Pick and shovel
DEPTH TO GROUND WATER: 1.1 — DATE HOLE STARTED: 14 Sep — COMPLETED: 14 Sep
EL. TOP OF HOLE: 821.3 — Geologist: R. Sperry

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				Sandy GRAVEL		Coarse grained sand
1.0				Water table		
				Note: 1. Location approximate, no survey control.		
				Temporary designation LLTP 11		

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 15

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION (Coordinates or Station): N E
DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO.: FIELD LLTP 12 — PERMANENT TP 16
NAME OF DRILLER: Caskey & Nielsen — WEATHER: Rainy
TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
TOTAL DEPTH OF HOLE: 3.9
DATUM FOR ELEVATION SHOWN: [ ] TBM [X] MSL — TYPE OF EQUIPMENT: Pick and shovel
TOTAL NO. OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed — DATE HOLE STARTED: 15 Sep — COMPLETED: 15 Sep
EL. TOP OF HOLE: 821.9 — Geologist: R. Sperry

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1.0		1	GP	Sandy GRAVEL	7"	
2.0						
3.0						
4.0						
				Note: 1. Location approximate, no survey control.		
				Temporary designation LLTP 12		

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 16

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 2
LOCATION (Coordinates or Station): N E
DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO.: FIELD LLTP 15 — PERMANENT TP 65
NAME OF DRILLER: Wieler — WEATHER: Cloudy
TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
TOTAL DEPTH OF HOLE: 8.2
DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Pick and shovel
TOTAL NO. OF SAMPLES: 6 — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: 7.2 — DATE HOLE STARTED: 25 Oct — COMPLETED: 31 Oct
EL. TOP OF HOLE: 826.6 — Geologist: Lachel

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
		15A				Coarse sand to large cobbles-well rounded field estimate 40% sand gravel predominantly rounded qtz. diorite with sparse basalt.
1.0				Sandy GRAVEL	15"	
		15B				
2.0						
		15C				
3.0						
4.0						
5.0				Sandy Gravel	12"	Coarse sand to large cobbles less large material field estimate 50% SAND
6.0				Gravelly SAND	4"	Predominantly sand approx. 70% by vol. fine to coarse grained.
7.0				Temporary Designation		

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 65 (LLTP 15)

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT: Snettisham — SHEET 2 OF 2
LOCATION (Coordinates or Station): N E
DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO.: FIELD LLTP 15 — PERMANENT TP 65
NAME OF DRILLER: WIELER — WEATHER: Cloudy
TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
TOTAL DEPTH OF HOLE: 8.2
DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Pick and shovel
TOTAL NO. OF SAMPLES: 6 — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: 7.2 — DATE HOLE STARTED: 25 Oct — COMPLETED: 31 Oct
Geologist: Lachel

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				Gravelly SAND		Water level 1000 hrs/31 Oct.
8.0						
9.0				NOTE: 1. Samples 15 D - 15 F marked as to depth taken on samples. 2. Samples taken weight approx. 100 lbs. per bag for a total of 600 lbs. of samples from this test pit. 3. Location approximate, no survey control. 4. Field classification, no laboratory test at this time.		
				Temporary designation		

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 65 (LLTP 15)

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 1
LOCATION (Coordinates or Station): N E
DRILLING AGENCY: [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO.: FIELD LLTP 16 — PERMANENT TP 66
NAME OF DRILLER: Wieler — WEATHER:
TYPE OF HOLE: TEST PIT [X] AUGER HOLE [ ] CHURN DRILL [ ]
TOTAL DEPTH OF HOLE: 4.0
DATUM FOR ELEVATION SHOWN: [ ] TBM [ ] MSL — TYPE OF EQUIPMENT: Shovel and pick
TOTAL NO. OF SAMPLES: 1 — TYPE OF SAMPLES: Disturbed — DATE HOLE STARTED: 31 Oct — COMPLETED: 31 Oct
Geologist: Lachel

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
						Fine to med grained no rock found in digging.
1.0			SW	SAND		
		1				
2.0						
3.0			SC	Varved SAND		Clay seams, plastic, blue gray ¼" thick seperating sand layers 3-4" thick.
4.0				NOTE: 1. Sample weighs approx. 100 lbs. 2. Location approximate, no survey control. 3. Field classification given, no laboratory tests at this time.		
				Temporary Designation		

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham — PERMANENT HOLE NO TP 66 (LLTP 16)

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

- Project: Snettisham — Sheet 1 of 1
- Drilling agency: Corps of Engineers
- Hole No.: Field LLTP 13 — Permanent TP 17
- Name of driller: Nielsen & Caskey — Weather: Rainy
- Type of hole: Test pit
- Depth to: 3.3 — Total depth of hole: 3.3
- Size and type of bit: Hand dug
- Datum for elevation shown: MSL
- Type of equipment: Pick and Shovel
- Total no. of samples: One — Type of samples: Disturbed
- Date hole started: 15 Sep — Completed: 15 Sep
- El. top of hole: 827.8 — Geologist: R. Sperry

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
1.0, 2.0, 3.0		1		Sandy GRAVEL	12"	Well graded alluvial. Water table not reached in this hole.

NPA Form 19 (Rev)

PROJECT Snettisham — PERMANENT HOLE NO. TP 17

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

- Project: Snettisham — Sheet 1 of 1
- Drilling agency: Corps of Engineers
- Hole No.: Field LLTP 14 — Permanent TP 64
- Name of driller: Wieler — Weather: Broken
- Type of hole: Test pit
- Total depth of hole: 4.2
- Type of equipment: Pick and shovel
- Total no. of samples: 10 — Type of samples: Disturbed
- Depth to ground water: 2.9
- Date hole started: 25 Oct — Completed: 25 Oct
- El. top of hole: 818.7 — Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
1.0		14A, 14B	SP	Gravelly SAND	4"	Sand predominantly fine grained well rounded cobbles field estimate of 70%.
2.0–4.0		14C, 14D	GP	Sandy GRAVEL	5"	Gravel predominantly rounded qtz. diorite with sparse basalt. Water level 1100 hrs/14 Oct. Sand estimated at 50% by vol.

NOTE:
1. Samples 14 E - 14 I marked as to depth taken on samples.
2. Samples taken weight approx. 100 lbs. each a total of 1000 lbs. of samples from this test pit.
3. Location approximate, no survey control.
4. Field classification given, no laboratory tests at this time.

Temporary designation

NPA Form 19 (Rev) Dec 1959

PROJECT Snettisham — PERMANENT HOLE NO. TP 64 — LLTP 14

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

- Project: Snettisham — Sheet 1 of 1
- Drilling agency: Corps of Engineers
- Hole No.: Field LLTP 17 — Permanent TP 67
- Name of driller: Wieler — Weather: Cloudy
- Type of hole: Test pit
- Total depth of hole: 4.6
- Type of equipment: Pick and shovel
- Total no. of samples: 1 — Type of samples: Disturbed
- Depth to ground water: 3.4
- Date hole started: 31 Oct — Completed: 31 Oct
- Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
1.0–4.0		1	GW	Sandy GRAVEL	3"	Coarse sand and well rounded gravel sand estimated at 50% by volume. Chiefly quartz diorite some basalt and qtz. Water table 31 Oct 1430 hrs.

NOTE:
1. Sample weights approx. 100 lbs.
2. Location approximate, no survey control.
3. Field classification given. No laboratory tests at this time.

Temporary Designation

NPA Form 19 (Rev)

PROJECT Snettisham — PERMANENT HOLE NO. TP 67 — LLTP 17

Revision	Date	Description	By

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE ALASKA

DESIGNED: Wm. B. Trautwein	SNETTISHAM PROJECT, ALASKA
DRAWN: Wm. B. Trautwein	FIRST STAGE DEVELOPMENT
CHECKED: D. Hansen	TEST PITS
PREPARED:	**LOG RECORD NO. 11**

SUPERVISED: M A Dixon — Chief, Geology Section	APPROVED: Clair? Farley — Colonel, CE, District Engineer
SUBMITTED: [signature] — Chief, Foundations & Materials Branch	SCALE — DATE: 20 Oct 65
RECOMMENDED: Warren George — Chief, Engineering Division	FILE NUMBER
	SHEET OF

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: See Photo attached.
Drilling agency: Corps of Engineers
Hole No.: Field L.L.T.P. 18 — Permanent TP 68
Name of driller: Wieler
Weather: Cloudy
Type of hole: Test pit
Total depth of hole: 3.5
Type of equipment: Pick and Shovel
Total no. of samples: 2 — Type of samples: Disturbed
Started: 31 Oct — Completed: 31 Oct
Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		18A	CP	Gravelly Sand	3"	Sand Med - coarse grained gravel well rounded approx. 50 sand by volume.
1.0						
		18B	GW	Sandy GRAVEL	5"	Sand med- coarse grained a few cobbles to 5" in dia. Gravel and cobbles all well rounded. Qtz. diorite dominent a few basalt and quartz gravels.
2.0						
3.0						
4.0						
						Samples weight approx. 100 lbs per bag sample.
5.0						

Temporary designation. (LLTP 18)

Project: Snettisham — Permanent Hole No. TP 68

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Drilling agency: Corps of Engineers
Hole No.: Field TP-75 — Permanent TP-75
Name of driller: O'Brien
Weather: Clear & Hot
Type of hole: Test pit
Total depth of hole: 3.5
Size and type of bit: Hand Dug
Type of equipment: Pick & shovel
Total no. of samples: One — Type of samples: Disturbed
Depth to ground water: 2.5
Started: 9 Jul 65 — Completed: 9 Jul 65
Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
				SAND		Fine grained sand and rock flour, some silt, gray organic material, (roots, moss, etc.) Slight amount of limonite staining at bottom of layer.
1						
2		75-A		SAND		Clean, well graded fine to coarse, gray biotite mica flakes.
				Water Table - approx. same level as stream 35' away.		
3				Gravelly SAND	4"	Well graded sand and gravel to 2", occasional to 4", predominantly quartz diorite.
4				NOTE: Location at Head of Long Lake - North east end of test pit base line at Sta. 0+00.		
				No sample of bottom layer due to water in hole.		
				Sample weighs approx. 100 lbs.		
5						

Project: SNETTISHAM - Head of Long Lake — Permanent Hole No. TP-75

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Drilling agency: Corps of Engineers
Hole No.: Field TP-76 — Permanent TP-76
Name of driller: O'Brien
Weather: Clear & hot
Type of hole: Test pit
Total depth of hole: 3.5
Size and type of bit: Hand Dug
Type of equipment: Pick & shovel
Total no. of samples: One — Type of samples: Disturbed
Depth to ground water: 2.5
Started: 9 Jul 65 — Completed: 9 Jul 65
Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
				SAND		Fine grained sand & rock flour, some silt, gray to brown, organic material, small amount of limonite staining at bottom.
1						
2		76-A		Gravelly SAND	3"	Well graded sand and gravel. Rounded gravel predominantly quartz diorite.
				Water Table.		
3						
4				Hole abandon due to caving and contamination from above.		
				NOTE: Location at Head of Long Lake, test pit base line at Sta. 2+00.		
				Sample weighs approx. 100 lbs.		
5						

Project: SNETTISHAM - HEAD OF LONG LAKE — Permanent Hole No. TP-76

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Drilling agency: Corps of Engineers
Hole No.: Field TP-79 — Permanent TP-79
Name of driller: O'Brien
Weather: Clear & Hot
Type of hole: Test pit
Total depth of hole: 2.5
Size and type of bit: Hand Dug
Type of equipment: Pick & shovel
Total no. of samples: None
Depth to ground water: 1.0
Started: 9 Jul 65 — Completed: 9 Jul 65
Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
				Organics		Moss, roots, small amounts of sand.
				Sandy GRAVEL	1.5	Med - coarse grained sand rounded gravel
1					W.T.	
				SAND		Fine grained, gray, some Mica.
2						
3				Hole abandon due to caving and water in hole.		
				No samples taken.		
				Water filled hole to .5 after one hour.		
4						

Project: SNETTISHAM, HEAD OF LONG LAKE — Permanent Hole No. TP-79

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Drilling agency: Corps of Engineers
Hole No.: Field TP-80 — Permanent TP-80
Name of driller: O'Brien
Weather: Clear & Hot
Type of hole: Test pit
Total depth of hole: 3.5
Size and type of bit: Hand Dug
Type of equipment: Pick & Shovel
Total no. of samples: One — Type of samples: Disturbed
Started: 9 Jul 65 — Completed: 9 July 65
Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
				SAND		Fine grained - much organic material (roots, moss, grass, etc.)
1		80-A		SAND		Gray, fine to medium grained, mod. high mica content, some silt below 1.5' exhibits banding to .5".
2				Water table		
3				Sandy GRAVEL	4"	Well graded in all sizes rounded to sub-rounded gravel. Predominantly quartz diorite.
4				Hole abandon due to caving and water in hole.		
				Sample weights approx. 100 lbs.		
5						
6						
7						

Project: SNETTISHAM, HEAD OF LONG LAKE — Permanent Hole No. TP-80

...TMENT OF THE ARMY
...TH PACIFIC DIVISION
... ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1

Hole No. ...77 — Permanent TP-77

Name of Driller: O'Brien — Weather: Clear & Hot

Depth of Hole: 3.5

Type of Equipment: Pick & shovel

Type of Samples: Disturbed

Depth to Ground Water: 2.8 — Date Hole Started: 9 Jul 65 — Completed: 9 Jul 65

Geologist: Lachel

Sample No.	Soil Legend	Classification	Max. Size Particle	Formation Description & Remarks
		Slightly Silty SAND		Fine grained sand and rock flour. Some organic material gray to brown. Rust staining at bottom.
77-A		SAND and GRAVEL	4"	Well graded in all sizes. Rounded to sub-rounded gravel. Predominantly quartz diorite.
		Water Table		

NOTE: Location - Head of Long Lake - test pit base line Sta. 4+00
Sample weighs approx. 100 lbs.

PROJECT SNETTISHAM - Head of Long Lake — PERMANENT HOLE NO. TP-77

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1

Hole No. TP-78 — Permanent TP-78

Type of Hole: Test Pit

Name of Driller: O'Brien — Weather: Clear & Hot

Type of Equipment: Pick & shovel

Total No. of Samples: None — Type of Samples: Disturbed

Date Hole Started: 9 July 1965 — Completed: 9 July 1965

Geologist: Lachel

Depth Feet	Water Content	Sample No.	Soil Legend	Classification	Max. Size Particle	Formation Description & Remarks
				NOTE: Location - Head of Long Lake, test pit base line. Sta 6+00 - Station located in small swamp with 3" water cover. Dug to .5' in water. Abandon to time when water is lower - material beneath .5'. Organic material is sandy gravel.		

NPA FORM 55 (REV)

PROJECT SNETTHISHAM - HEAD OF LONG LAKE — PERMANENT HOLE NO. TP-78

Revision	Date	Description	By

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
TEST PITS
LOG RECORDS NO. 12

Designed: Wm. B. Trautwein
Drawn: Wm. B. Trautwein
Checked: D. Hansen
Prepared:
Supervised: [signature] — Chief, Geology Section
Submitted: [signature] — Chief, Foundations & Materials Branch
Recommended: Harris George — Chief, Engineering Division
Approved: [signature] — Colonel, CE, District Engineer
Scale — Date 20 Oct 65
File Number
Sheet of

2

PART 7 LOG RECORDS — CORE HOLES

DRILLING LOG — Hole No. DH 6 (Sheet 1 of 2)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM LONG LAKE DAM
Location	N 103,457 E 95,378
Drilling agency	CORP OF ENGINEERS
Name of driller	WM. BURGESS, DON METLER
Direction of hole	Vertical, 0
Thickness of overburden	0.0
Depth drilled into rock	201.0
Total depth of hole	201.0
Size and type of bit	NX
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	0 0
Total number core boxes	11
Date hole	9 JUN., 64 — 15 JULY, 64
Elevation top of hole	832.6
Total core recovery for boring	199.9' 99.4

Elevation: 833 · 828 · 788 · 733 (depth 0–100)

- QUARTZ DIORITE, MED. TO CSE. GR., BLACK GRAY & WHITE
- LT. WEA., MOD. HARD, FRACT. ZONE
- DIORITE ZONES, MOD. HARD FINE GR., BLACK, GRAY & WHITE
- QTZ DIORITE, HARD, MASSIVE, FRESH

% core recovery: 100, 91, 73, 100, 98, 95, 100 · Box no.: 1, 2, 3, 4, 5 · Sample depths: 9.4, 31.0, 56.2, 77.4

Remarks:
- 3" NX STARTER CORE
- CORE LENGTHS TO 0.7'
- 100% W.R., GRAY BLACK
- LOST DRILL W.R.
- CORE LENGTHS TO 2.7'
- W.R. VARIES 0-50%
- CORE LENGTHS TO 1.0'
- W.T. EL.
- CORE LENGTHS TO 4.3'
- CORE LENGTHS TO 5.7'
- 5 TO 25% WATER RETURN DARK GRAY
- 25 TO 40% WATER RETURN DARK GRAY

DRILLING LOG — Hole No. DH 6 (Sheet 2 of 2)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM LONG LAKE DAM
Location	N 103,457 E 95,378
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER
Direction of hole	Vertical, 0
Thickness of overburden	0.0
Depth drilled into rock	201.0'
Total depth of hole	201.0'
Size and type of bit	NX
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	0 0
Total number core boxes	11
Date hole	9 JUNE, 1964 — 15 JULY, 1964
Elevation top of hole	832.6'
Total core recovery for boring	199.9' 99.4

Elevation: 732 · 632 (depth 100–200)

- QUARTZ DIORITE, HARD, CSE. TO MED. GR., MASSIVE FRESH WHITE & BLACK
- BOTTOM OF HOLE EL. 531.6'
- DEPTH OF HOLE 201.0'
- THICKNESS OF O.B. 0.0'
- ROCK CORED 201.0'
- CORE RECOVERED 199.9'
- % CORE RECOVERED

% core recovery: 100 · Box no.: 6, 7, 8, 9, 10, 11 · Sample depths: 100.4, 122.4, 141.0, 159.6, 178.0, 195.9, 201.0

Remarks:
- 15 TO 20% GRAY WATER RETURN
- CORE LENGTHS TO 10.0'
- LOST DRILL WATER RETURN
- 5 TO 10% GRAY WATER RETURN

DRILLING LOG — Hole No. DH 7 (Sheet 1 of 3)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM LONG LAKE DAM
Location	N 103,460 E 95,381
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER, WM. BURGESS
Direction of hole	Inclined, 40, BEARING N 27°E
Thickness of overburden	0.0
Depth drilled into rock	275.9'
Total depth of hole	275.9'
Size and type of bit	NX
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	0 0
Total number core boxes	16
Date hole	16 JULY, 64 — 27 JULY, 64
Elevation top of hole	832.3'
Total core recovery for boring	271.1' 98.3

Elevation: 832 · 828 · 824 · 821 · 816 · 809 · 802 · 788 · 750 (depth 0–100)

- QUARTZ DIORITE MOD HARD CSE. GR., WHITE & BLACK LT. WEA.
- DIORITE MOD. HARD, FINE GR., BLACK & WHITE
- DIORITE AS ABOVE FINE TO MED. GR., MOD. TO HEA. WEA., CL. FRAC., HI CORE LOSS
- QUARTZ DIORITE, HARD, MED. TO CSE. GR., WHITE & BLACK QUARTZ SEAMS COMMON

% core recovery: 100, 99, 81, 100, 99, 60, 100 · Box no.: 1, 2, 3, 4, 5, 6 · Sample depths: 19.9, 42.5, 60.8, 79.0, 97.4

Remarks:
- LOST DRILL WATER RETURN
- CORE LENGTHS TO 0.8'
- W.T. @ 27 JULY, 1964 CORE LENGTHS TO 1.9'
- DRILLER HIT SOFT SPOT@36.6' FAST RATE OF PENETRATION
- CORE LENGTHS TO 1.8'
- CORE LENGTHS TO 7.7'
- CORE LENGTHS TO 2.6'
- CORE LENGTHS TO 9.6'

DRILLING LOG — Hole No. DH 8 (Sheet 1 of 2)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM LONG LAKE DAM
Location	N 103,364 E 95,294
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER
Direction of hole	Vertical, 0
Thickness of overburden	0.4'
Depth drilled into rock	199.6'
Total depth of hole	200.0'
Size and type of bit	NX
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0 0
Total number core boxes	13
Date hole	17 JULY, 1964 — 22 JULY, 1964
Elevation top of hole	817.9
Total core recovery for boring	197.7' 99.0

Elevation: 817.9 · 816 · 809 · 797 · 784 · 775 · 744 · 740 · 739 · 730 · 727 · 722 · 720 · 718 (depth 0–100)

- MOSS, SANDY GRAVEL
- QUARTZ DIORITE, HARD MED TO CSE. GR.
- CL. FRAC. MOD. WEA. RUST STAINED
- FRAC., LT. WEA.
- QTZ. DIO., MASSIVE, FRESH OCCASIONAL QUARTZ SEAMS TO 1.0' SIZE
- MOD. WEA., RUST STAINED OPEN LOW ANGLE JOINTING
- QTZ. DIO., MOD. HARD, LT. WEA. WHITE, GRAY & BLACK
- RUST STAINED FRACTURE ZONES

% core recovery: 86, 83, 64, 100, 96, 100 · Box no.: 1, 2, 3, 4, 5, 6 · Sample depths: 7.0, 23.5, 43.4, 61.7, 80.3

Remarks:
- 100% GRAY DRILL WATER RETURN
- 3" NX STARTER CORE
- CORE LENGTHS TO 1.1'
- CORE LENGTHS TO 5.3'
- CORE LENGTHS TO 7.2'
- 100-80% GRAY W.R. GRADUAL LOSS OF DRILL WATER
- CORE LENGTHS TO 1.6'
- 80-40% GRAY W.R.
- LOST DRILL WATER
- GRADUAL WATER RETURN 0-40% GRAY W.R.

DRILLING LOG — Hole No. DH 8 (Sheet 2 of 2)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM LONG LAKE DAM
Location	N 103,364 E 95,294
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER
Direction of hole	Vertical, 0
Thickness of overburden	0.4
Depth drilled into rock	199.6'
Total depth of hole	200.0'
Size and type of bit	NX
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0 0
Total number core boxes	13
Date hole	17 JULY 1964 — 22 JULY 1964
Elevation top of hole	818.1
Total core recovery for boring	197.7 99.0

Elevation: 717.9 · 711 · 618 (depth 100–200)

- QUARTZ DIORITE (AS BEFORE)
- QTZ. DIO., HARD, MASSIVE FRESH OCCAS. QTZ. & DIORITE SEAMS
- BOTTOM OF HOLE 717.9'

% core recovery: 100 · Box no.: 7, 8, 9, 10, 11, 12, 13 · Sample depths: 110.1, 125.0, 140.0, 155.2, 175.4, 184.9

Remarks:
- GRAY W.R., VARIES 0-20%
- CORE LENGTHS TO 1.2'
- CORE LENGTHS TO 5.7'
- CORE LENGTHS TO 10.1'
- NO WATER RETURN

DRILLING LOG — Hole No. DH 9 (Sheet 1 of 2)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM LONG LAKE D. S.
Location	N 103,308 E 95,297
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER
Direction of hole	Inclined, 45, BEARING N 30°E
Thickness of overburden	0.0'
Depth drilled into rock	162.8'
Total depth of hole	162.8'
Size and type of bit	NX
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0 0
Total number core boxes	12
Date hole	23 JULY, 1964 — 25 JULY, 1964
Elevation top of hole	818.4'
Total core recovery for boring	160.3' 98.46

Elevation: 818.4 · 807 (depth 0–100)

- QUARTZ DIORITE, MOD. HARD, MOD. WEA., RUST STAINED
- QTZ. DIO., HARD, MED. TO CSE. WHITE, BLACK, GRAY MASSIVE, FRESH

% core recovery: 90, 56, 75, 89, 100 · Box no.: 1, 2, 3, 4, 5, 6, 7, 8 · Sample depths: 5.0, 20.7, 35.5, 50.6, 65.4, 80.2, 96.9

Remarks:
- 3" NX STARTER CORE
- 100% GRAY W.R.
- CORE LENGTHS TO 0.9'
- CORE LENGTHS TO 3.0'
- 100-80% W.R., GRAY
- CORE LENGTHS TO 9.1'
- 80-50% W.R., GRAY
- GRADUAL LOSS OF DRILL WATER RETURN WITH DEPTH
- 50-20% W.R., GRAY
- CORE LENGTHS TO 5.8'
- CORE LENGTHS TO 10.0'
- 20-1?% W.R., GRAY

U. S. ARMY

DRILLING LOG — NORTH PACIFIC — ALASKA — Hole No. DH 7 — Sheet 2 of 3 sheets

SNETTISHAM LONG LAKE DAM
N 103,460 E 95,381
CORPS OF ENGINEERS
WM. BURGESS, AARON CURTIS
BEARING N 27°E
40
0.0
275.9
275.9
NX
JOY 12 B 400
0 0
16
16 JULY, 64 27 JULY, 64
832.3
271.1 98.3

ELEVATION 756

DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
	QUARTZ DIORITE (AS BEFORE)	97	6	NO WATER RETURN CORE LENGTHS TO 10.1'
110				
			115.4	
120			7	
130			134.1	
140			8	
150		100	152.4	
160			9	
170			170.7	
180			10	
190	PYRITE	99	188.3	
200		100	11	

DRILLING LOG — NORTH PACIFIC — ALASKA — Hole No. DH 7 — Sheet 3 of 3 sheets

SNETTISHAM LONG LAKE DAM
N 103,460 E 95,381
CORPS OF ENGINEERS
WILLIAM BURGESS
BEARING N 27°E
40
0.0
275.9'
275.9
NX
JOY 12 B 400
0 0
16
16 JULY, 64 27 JULY, 64
832.3
271.1 98.3

ELEVATION 679.5

DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
	QUARTZ DIORITE (AS BEFORE)		11	NO WATER RETURN CORE LENGTHS TO 10.0
			204.0	
210	QUARTZ FELDSPAR ZONES		12	
220			218.6	
			13	
230		100	233.6	
240			14	
250			248.6	
			15	
260			263.6	
270			16	
621.0 275.9				

BOTTOM OF HOLE EL. 620.6'
DEPTH OF HOLE 275.9'
THICKNESS OF O.B. 0.0
ROCK CORED 275.9'
CORE RECOVERED 271.1'
% CORE RECOVERED 98.3
VERTICAL DEPTH 211.2'
HORIZONTAL DISTANCE 176.3'

GENERAL NOTES:

1. FOR COMPLETED EXPLORATIONS -- SEE PLATE AND PLATE
2. CORE DRILL HOLES (PREFIXED WITH DH) WERE DRILLED PRIMARILY FOR THE PURPOSE OF DETERMINING ELEVATION AND QUALITY OF BEDROCK. OVERBURDEN DESCRIPTIONS ARE BASED ON VISUAL CLASSIFICATION OF BAILER OR WASH SAMPLES, AND THEY WERE FOR THE PURPOSE OF DETERMINING GENERAL TYPES OF OVERBURDEN. CLASSIFICATIONS OF OVERBURDEN MATERIALS FROM THESE EXPLORATIONS SHALL NOT BE INTERPRETED AS BEING PRECISE, AND BECAUSE OF THE METHODS USED MAY VARY CONSIDERABLY FROM THE ACTUAL CONDITIONS.
3. CARE SHALL BE EXERCISED IN INTERPOLATING DATA BETWEEN EXPLORATIONS AND THE DATA SHALL BE USED ONLY TO THE DEGREE OF RELIABILITY INHERENT IN THE TYPE OF EXPLORATION.
4. EXPLORATIONS OFTEN INDICATE THE PRESENCE OF BOULDERS GENERALLY THROUGHOUT THE FORMATION. THE ABSENCE OF BOULDERS IN ANY DRILL HOLE DOES NOT NECESSARILY INDICATE THE ABSENCE OF BOULDERS IN THE AREA, AND THE SIZE OF BOULDERS ENCOUNTERED IN THE BORING DOES NOT INDICATE THAT LARGER BOULDERS WILL NOT BE ENCOUNTERED.
5. "K" VALUES SHOWN ON LOGS ARE OBTAINED BY MATHEMATICAL COMBINATIONS OF FLOW AND HEADS FOR EACH TEST ZONE. THEY ARE EXPRESSED IN TERMS OF FT/MIN. X 10^{4}.

ABBREVIATIONS

CL. = CLOSELY
CSE. = COARSE
FRAC. = FRACTURED
GR. = GRAINED
HEA. = HEAVY
HI. = HIGH
LT. = LIGHTLY
MED. = MEDIUM
MOD. = MODERATELY
O.B. = OVERBURDEN
OCCAS. = OCCASIONAL
PRESS. TEST = PRESSURE TEST
QTZ. = QUARTZ
QTZ. DIO. = QUARTZ DIORITE
SLICKS. = SLICKENSIDES
WEA. = WEATHERED
W.R. = WATER RETURN
W.T. = WATER TABLE

QUALITY NOTES:

HARD = CAN BE SCRATCHED ONLY WITH DIFFICULTY OR NOT AT ALL WITH KNIFE BLADE.
MOD. HARD = CAN JUST BE WELL SCRATCHED WITH KNIFE BLADE.
MOD. SOFT = CAN BE EASILY SCRATCHED WITH KNIFE BLADE -- MAY BECOME SOMEWHAT CRUMBLY -- RELATIVELY HIGH CORE LOSSES POSSIBLE.
SOFT = CAN BE EASILY GOUGED OR CUT BY KNIFE BLADE -- MAY BECOME VERY CRUMBLY -- VERY HIGH CORE LOSSES PROBABLE.

REVISION DATE DESCRIPTION BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORD NO. 1

DESIGNED: Wm. B. Trautman
DRAWN: Wm. B. Trautman
CHECKED: W. G. Binkley
PREPARED:
SUPERVISED: M. C. Dixon — CHIEF, GEOLOGY SECTION
SUBMITTED: CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Jarrett George — CHIEF, ENGINEERING DIVISION
APPROVED: Clare F. Farley — COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

CORPS OF ENGINEERS

DRILLING LOG — Hole No. DH 9

Division	NORTH PACIFIC
Installation	ALASKA
Sheet	2 of 2 sheets
Project	SNETTISHAM LONG LAKE D. S.
Location	N 103,368 E 95,297
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER
Direction of hole	Inclined 45° BEARING N 36 E
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	Disturbed 0, Undisturbed 0
Total number core boxes	12
Date hole	Started 23 JULY, 1964; Completed 25 JULY, 1964
Elevation top of hole	818.4
Thickness of overburden	0.0
Depth drilled into rock	162.8
Total depth of hole	162.8
Total core recovery for boring	160.3' — 98.46 %

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
747.7		QUARTZ DIORITE (AS BEFORE)		8	INTERMITTENT W. R. 0-20% GRAY; CORE LENGTHS TO 10.0'
	110			109.9	
				9	
731	120	DIORITE, MOD. HARD, FINE GR., GRAY BLACK		124.6	0-10% W. R., GRAY
727	130		100	10	
	140			139.4	
				11	NO WATER RETURN
	150			154.2	
				12	
703	160			162.8	

BOTTOM OF HOLE EL. 703.3'
DEPTH OF HOLE 162.8
THICKNESS OF O.B. 0.0'
ROCK CORED 162.8
CORE RECOVERED 160.3
% CORE RECOVERY 98.5
VERTICAL DEPTH 115.1'
HORIZONTAL DISTANCE 115.1'

DRILLING LOG — Hole No. DH 10

Division	NORTH PACIFIC
Installation	ALASKA
Sheet	1 of 1 sheets
Project	SNETTISHAM LONG LAKE D. S.
Location	N 103,367 E 95,279
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER
Direction of hole	Inclined 55° BEARING N 6°
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0, 0
Total number core boxes	5
Elevation ground water	LAKE LEVEL
Date hole	Started 27 JULY, 1964; Completed 29 JULY, 1964
Elevation top of hole	817.0'
Thickness of overburden	0.0
Depth drilled into rock	63.3
Total depth of hole	63.3
Total core recovery for boring	62.3' — 98.4 %

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
817.0			75		3" NX STARTER CORE 100% DRILL WATER RETURN, GRAY
815		QUARTZ DIORITE, MOD. HARD, MOD. WEA., RUST STAINED; QTZ. DIO., HARD, LT. WEA., MED. TO CSE. GR., WHITE & BLACK	100		
	10		98	1	CORE LENGTHS TO 1.1'
			99	16.4	CORE LENGTHS TO 3.5'
	20	OCCAS. QTZ. SEAMS		2	
	30			31.0	CORE LENGTHS TO 4.6
	40	QTZ. DIO., MASSIVE, FRESH	100	3	90-50% W. R., GRAY GRADUAL DECREASE IN WATER RETURN WITH DEPTH
	50			45.9	
				4	CORE LENGTHS TO 5.7'
	60			60.3	HOLE BOTTOMED OUT IN LAKE, LEFT 0.7' CORE ON BOTTOM
781	63.3			5	

BOTTOM OF HOLE EL. 780.8'
DEPTH OF HOLE 63.3'
THICKNESS OF O.B. 0.0'
ROCK CORED 63.3'
CORE RECOVERED 62.3'
% CORE RECOVERY 98.4
VERTICAL DEPTH 36.3'
HORIZONTAL DISTANCE 51.9'

EXTENDED CORE BARREL 10.0' OUT INTO LAKE

DRILLING LOG — Hole No. DH 11

Division	NORTH PACIFIC
Installation	ALASKA
Sheet	1 of 2 sheets
Project	SNETTISHAM LONG LAKE D. S.
Location	N 103,462 E 95,377
Drilling agency	CORPS OF ENGINEERS
Name of driller	WM. BURGESS, AARON CURTIS
Direction of hole	Inclined 60° BEARING N 13° W
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	0, 0
Total number core boxes	7
Elevation ground water	LAKE LEVEL
Date hole	Started 27 JULY, 1964; Completed 1 AUG., 1964
Elevation top of hole	831.9'
Thickness of overburden	0.8'
Depth drilled into rock	110.0'
Total depth of hole	110.8'
Total core recovery for boring	90.2' — 81.3 %

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
832		DIORITE, MOD. HARD, FINE GR., BLACK & WHITE	100	1	3" NX STARTER CORE; CORE LENGTHS TO 1.3'
		MOD. WEA., RUST STAINED FRAC.	84		
827	10	QUARTZ DIORITE, HARD, CSE. GR., LT. WEA., WHITE & BLACK	75	3.7	100% GREEN W. R.; SOFT GREEN CLAY SEAMS LOSS DUE TO WASHING
			100	2	CORE LENGTHS TO 5.0'
821	20	QUARTZ DIORITE-HARD, MED. TO CSE. GR., WHITE & BLACK		20.2	CORE LENGTHS TO 1.3'; CORE LENGTHS TO 7.0'; 100% GREEN GRAY W. R.
	30			3	CORE LENGTHS TO 4.2'
				33.9	
	40		96	4	80% GREEN GRAY W. R.; CORE LENGTHS TO 0.5'
	50			49.5	CORE LENGTHS TO 8.4'; 80-50% GRAY W. R.
			100	5	50-25% GRAY W. R. GRADUAL LOSS WITH DEPTH; CORE LENGTHS TO 1.0'
802	60	FRAC., RUST STAINED	VOID	64.4	
800		OPEN FISSURE	64		6" ROD DROP, NO W. R.; CORE HEAVILY GROUND
798	70	ZONE OF HIGH CORE LOSS; OPEN FISSURES, SOFT SEAMS	VOID	6	SOME LOSS DUE TO GRINDING & WASHING; 1.0' ROD DROP; CORE LENGTHS TO 3.2'
796					
	80	DIORITE-MOD. HARD TO HARD CSE. GR., BLACK & WHITE	73	81.3	CORE LENGTHS TO 0.5'
789		OPEN FISSURE	VOID		2.0' ROD DROP
788		QUARTZ DIORITE & FELSITE			
787	90	HARD, CL. FRAC.		7	REAMED NX CASING TO 95.0'
785		OPEN FISSURE			
782	100	QUARTZ DIORITE, HARD	67		CORE LENGTHS TO 4.5'

DRILLING LOG — Hole No. DH 12 (Sheet 2 of 4 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM-LONG LAKE D.S.
Location	N 103,090 E 95,240
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER
Direction of hole	Inclined 55° BEARING N 77°W
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0, 0
Total number core boxes	22
Date hole	Started 5 AUG., 1964; Completed 11 AUG., 1964
Elevation top of hole	865.5'
Thickness of overburden	12.5'
Depth drilled into rock	325.2'
Total depth of hole	337.7'
Total core recovery for boring	320.3' — 98.49 %

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
858		QUARTZ DIORITE, HARD, MED. TO CSE. GR., WHITE & BLACK, FRESH, MASSIVE, QTZ. DOMINANT		7	NO WATER RETURN; CORE LENGTHS TO 16.2'
	110			113.4	CORE LENGTHS TO 1.5'
	120			8	
	130	DIORITE		128.2	
				9	
	140			143.0	
	150		100	10	CORE LENGTHS TO 4.3'
				158.2	
	160			11	CORE LENGTHS TO 7.2'
	170			173.3	
	180			12	
	190			188.4	CORE LENGTHS TO 10.1'
751	200			13	

DRILLING LOG — Hole No. DH 12 (Sheet 3 of 4 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM-LONG LAKE D.S.
Location	N 103,090 E 95,240
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER
Direction of hole	Inclined 55° BEARING N 77°W
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0, 0
Total number core boxes	22
Date hole	Started 5 AUG., 1964; Completed 11 AUG., 1964
Elevation top of hole	865.5'
Thickness of overburden	12.5'
Depth drilled into rock	325.2'
Total depth of hole	337.7'
Total core recovery for boring	320.3' — 98.49 %

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
751		QUARTZ DIORITE-HARD, MED. TO CSE. GR., MASSIVE, WHITE & BLACK, FRESH		13	CORE LENGTHS TO 5.6
				203.6	NO WATER RETURN
	210			14	CORE LENGTHS TO 2.7'
	220			218.5	
				15	
	230			233.3	CORE LENGTHS TO 8.4'
	240	OCCASIONAL QTZ SEAMS		16	
	250		100	248.3	
				17	
	260			263.2	CORE LENGTHS TO 4.5'
	270			18	
	280			278.0	
				19	
	290			293.2	
	300		99	20	CORE LENGTHS TO 0.7'

DRILLING LOG — Hole No. DH 12 (Sheet 4 of 4 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM-LONG LAKE D.S.
Location	N 103,090 E 95,240
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON MELTER
Direction of hole	Inclined 55° BEARING N 77°W
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0, 0
Total number core boxes	22
Date hole	Started 5 AUG., 1964; Completed 11 AUG., 1964
Elevation top of hole	865.5'
Thickness of overburden	12.5'
Depth drilled into rock	325.2'
Total depth of hole	337.7'
Total core recovery for boring	320.3' — 98.49 %

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
593		QUARTZ DIORITE (AS BEFORE)	100		NO WATER RETURN; CORE LENGTHS TO 6.4
592				307.7	
	310				
586		STRIATED SLICKS, DIP 60°-70°, SOFT SLIPPERY COATINGS 1/16" TO 1/8" THICK	99	21	
584					
	320			322.6	
	330		100	22	
572	337.7			337.7	

BOTTOM OF HOLE EL. 571.8'
DEPTH OF HOLE 337.7'
THICKNESS OF O.B. 12.5'
ROCK BITTED 5.0'
O.B. CORED 7.5'
ROCK CORED 325.2'
CORE RECOVERED 320.3
% CORE RECOVERY 98.49
VERTICAL DEPTH OF HOLE 193.7'
HORIZONTAL DISTANCE 276.6

U. S. ARMY

DRILLING LOG — Hole No. DH 1

Division	NORTH PACIFIC
Installation	ALASKA
Sheet	2 of 2 sheets
Project	SNETTISHAM LONG LAKE D.S.
Location	N 103,462 E 95,377
Drilling agency	CORPS OF ENGINEERS
Name of driller	AARON CURTIS, DON METLER
Direction of hole	60 BEARING N 13° W
Thickness of overburden	0.8
Depth drilled into rock	110.0
Total depth of hole	110.8
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	0 0
Total number core boxes	7
Elevation ground water	LAKE LEVEL
Date hole	Started 27 JULY, 1964; Completed 1 AUG., 1964
Elevation top of hole	831.5
Total core recovery for boring	90.2 81.3

Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
	QUARTZ DIORITE (AS BEFORE)			ABANDONED HOLE AS WE COULD NOT RUN CASING DEEPER AND DID NOT WISH TO RISK CORE BARREL BY DRILLING DEEPER
	GRAVELLY CLAY	67	7	
110		5	110.8	

BOTTOM OF HOLE	EL. 776.1'
DEPTH OF HOLE	110.8
THICKNESS OF O. B.	0.8
ROCK CORED	110.0
CORE RECOVERED	90.2'
% CORE RECOVERED	81.3
VERTICAL DEPTH	56.0'
HORIZONTAL DISTANCE	95.0'

DRILLING LOG — Hole No. DH 12

Division	NORTH PACIFIC
Installation	ALASKA
Sheet	1 of 4 sheets
Project	SNETTISHAM LONG LAKE D.S.
Location	N 103,090 E 95,240
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON METLER
Direction of hole	Inclined 55 BEARING N 77° W
Thickness of overburden	12.5'
Depth drilled into rock	325.2'
Total depth of hole	337.7'
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0 0
Total number core boxes	22
Date hole	Started 5 AUG., 1964; Completed 11 AUG., 1964
Elevation top of hole	885.5'
Total core recovery for boring	320.0' 98.49

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
866		CLAYEY SILT, ORGANIC WITH COARSE ANGULAR TALUS			ROCK BITTED, WASHED & CHOPPED CASING TO 5.0' DEPTH
			56		START OF NX CORE 100 % W.R., BROWN
			44		
860	10	BASALT HARD, DENSE, APHANITIC CL. FRACT., MOD. WEA.	50		PROBABLE DIKE POSSIBLE BOULDER
858		QUARTZ DIORITE HARD, MED. GR., WHITE & BLACK	90	1	100% W.R., GRAY CORE LENGTHS TO 4.8'
	20		99	22.7	
			60		LOST DRILL WATER CORE LENGTHS TO 1.2' NO WATER RETURN
	30			2	
		QTZ. DIO, MED. TO CSE. GR. LT. WEA.	99	38.5	
	40			3	
	50	OCCASIONAL QTZ & DIORITE SEAMS THROUGHOUT			CORE LENGTHS TO 7.5'
				53.9	
	60		100	4	
				65.6	
	70			5	
	80			83.5	CORE LENGTHS TO 0.6'
	90			6	CORE LENGTHS TO 5.3'
				98.4	
805.0	100				

DRILLING LOG — Hole No. DH 13

Division	NORTH PACIFIC
Installation	ALASKA
Sheet	1 of 1 sheets
Project	SNETTISHAM-LONG LAKE D.S.
Location	...708 E 95,612
Drilling agency	CORPS OF ENGINEERS
Name of driller	WM. BURGESS, AARON CURTIS
Direction of hole	30 BEARING N 31° E
Thickness of overburden	0.5'
Depth drilled into rock	95.0'
Total depth of hole	95.5'
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	0 0
Total number core boxes	7
Date hole	Started 5 AUG., 64; Completed 7 AUG., 64
Elevation top of hole	943.5'
Total core recovery for boring	95.0' 100 %

Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
	SILT, ORGANIC, BLACK		0.5'	HAND DUG
	QUARTZ DIORITE, HARD, CSE. TO MED. GRAINED BLACK & WHITE FRACT., LT WEA., MASSIVE, FRESH		1	100% GRAY W.R. CORE LENGTHS TO 0.9' CORE LENGTHS TO 6.8'
10			15.0'	LOST W.R. @17.8'
20			2	25% W.R., GRAY
30			29.5'	CORE LENGTHS TO 9.6'
			3	75 % W.R., GRAY
		100	44.3	100% W.R., GRAY
			4	
			59.2	
			5	
			74.3	
			6	75% W.R., GRAY
			89.4	
			7	
			95.5	

VERTICAL DEPTH 82.8'
HORIZONTAL DISTANCE 47.8'

NOTE:
SEE LOG RECORDS NUMBER 1 FOR NOTES AND LEGEND

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE ALASKA

DESIGNED: Wm. B. Trautwein
DRAWN: Wm. B. Trautwein
CHECKED: D. Hansen
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORD NO. 2

SUPERVISED: N. A. Dixon — CHIEF, GEOLOGY SECTION
APPROVED: [signature] — COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: [signature] — CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: [signature] — CHIEF, ENGINEERING DIVISION
SCALE
DATE 20 ... 65
FILE NUMBER
SHEET OF

2

CORPS OF ENGINEERS

Hole No. DH 14

DRILLING LOG — Division: NORTH PACIFIC — Installation: ALASKA — Sheet 1 of 3 sheets

Project: SNETTISHAM LONG LAKE D.S.
Location: N 103,714 E 95,605
Drilling agency: CORPS OF ENGINEERS
Name of driller: WM. BURGESS, AARON CURTIS
Direction of hole: ☐ Vertical ☒ Inclined 55 BEARING N 42° W
Thickness of overburden: 0.5'
Depth drilled into rock: 245.5'
Total depth of hole: 246.0'
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B 400
Total no. of overburden samples taken: 0 0
Total number core boxes: 17
Date hole: Started 10 AUG., 1964 Completed 15 AUG., 1964
Elevation top of hole: 946.6
Total core recovery for boring: 245.3' 99.9%

Elevation	Depth	Classification of materials	% Core Recov.	Box or Sample No.	Remarks
946.6					
946		SANDY SILT, ORGANIC	96		HAND DUG
		QUARTZ DIORITE, HARD MED. TO CSE. GRAINED WHITE AND BLACK, LT. WEA., FRAC.	100	1	100% W.R., GRAY CORE LENGTHS TO 1.2'
942	10	DIORITE, MOD. HARD, FINE TO MED. GR., BLACK AND WHITE, MASSIVE	90		CORE LENGTHS TO 9.9'
				15.3	
	20			2	
				29.8	
929	30	QUARTZ DIORITE, HARD MED. TO CSE. GR., WHITE AND BLACK	100	3	
	40			44.2	
	50			4	CORE LENGTHS TO 1.0' 100% W.R., GREEN
	60			59.2	
			98	5	CORE LENGTHS TO 4.2'
	70			74.4	
902		POSSIBLE FAULT, 0.8' MOD. SOFT, RUST BROWN DIP 15° - 20°			
900	80		100	6	CORE LENGTHS TO 1.7' CORE LENGTHS TO 1.0' CORE LENGTHS TO 3.2' 100% W.R., GRAY GREEN
	90			89.3	
				7	
889	100				

Hole No. DH 14

DRILLING LOG — Division: NORTH PACIFIC — Installation: ALASKA — Sheet 2 of 3 sheets

Project: SNETTISHAM LONG LAKE D.S.
Location: N 103,714 E 95,625
Drilling agency: CORPS OF ENGINEERS
Name of driller: WM. BURGESS, AARON CURTIS
Direction of hole: 55 BEARING N 42 W
Thickness of overburden: 0.5'
Depth drilled into rock: 245.5'
Total depth of hole: 246.0'
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B 400
Total no. of overburden samples taken: 0 0
Total number core boxes: 17
Date hole: 10 AUG., 1964 15 AUG., 1964
Elevation top of hole: 946.6'
Total core recovery for boring: 245.3' 99.9%

Elevation	Depth	Classification of materials	% Core Recov.	Box or Sample No.	Remarks
889		QUARTZ DIORITE (AS BEFORE)		7	100% W.R., GRAY GREEN CORE LENGTHS TO 4.9'
		PROBABLE FAULT, QUARTZ HEALED BRECCIA DIPS 20° TO 42°		104.0'	
	110			8	100% W.R., GRAY
				118.5'	
877	120	QUARTZ FELDSPAR WITH HORNBLENDITE XENOLITHS			
	130	HORNBLENDITE, MOD. HARD, GREENISH BLACK		9	CORE LENGTHS TO 7.4'
				133.5'	
869	140			10	100% W.R., GRAY TO BROWN
			100		CORE LENGTHS TO 0.8' CORE LENGTHS TO 3.4'
				148.0	
	150			11	CORE LENGTHS TO 9.8'
	160			162.7	
	170			12	
				177.3	CORE LENGTHS TO 6.8'
	180			13	
	190			192.2	100% W.R., MILKY WHITE
				14	
832	200				

Hole No. DH 14

DRILLING LOG — Division: NORTH PACIFIC — Installation: ALASKA — Sheet 3 of 3 sheets

Project: SNETTISHAM LONG LAKE D.S.
Location: N 103,714 E 95,605
Drilling agency: CORPS OF ENGINEERS
Name of driller: AARON CURTIS
Direction of hole: ☐ Vertical ☒ Inclined 55 BEARING N 42° W
Thickness of overburden: 0.5'
Depth drilled into rock: 245.5'
Total depth of hole: 246.0'
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B 400
Total no. of overburden samples taken: 0 0
Total number core boxes: 17
Date hole: 10 AUG., 1964 15 AUG., 1964
Elevation top of hole: 946.6'
Total core recovery for boring: 245.3' 99.9%

Elevation	Depth	Classification of materials	% Core Recov.	Box or Sample No.	Remarks
832		QUARTZ DIORITE, HARD, MED. TO CSE. GRAINED, WHITE AND BLACK, QTZ. DOMINANT		14	CORE LENGTHS TO 10.0' 100% GRAY W.R.
				206.9	
	210				
823		DIORITE, MOD. HARD, FINE MED. GR., BLACK & WHITE, MASSIVE, FRESH OCCAS. QTZ. SEAMS		15	
	220		100	221.9	
	230			16	
				236.9	
	240			17	
805.5	246			246.0	

BOTTOM OF HOLE EL. 805.5'
VERTICAL DEPTH 141.1'
HORIZONTAL DISTANCE 201.5'
DEPTH OF HOLE 246.0'
THICKNESS OF O.B. 0.5'
ROCK CORED 245.5'
CORE RECOVERED 245.3'
% CORE RECOVERY 99.9%

DRILLING LO
SNETT
N 103
805
864
837

Hole No. DH 15

DRILLING LOG — Division: NORTH PACIFIC — Installation: ALASKA — Sheet 1 of 4 sheets

Project: SNETTISHAM-LONG LAKE D.S.
Location: N 103,708 E 95,614
Drilling agency: CORPS OF ENGINEERS
Name of driller: DON METLER
Direction of hole: ☐ Vertical ☒ Inclined 45 BEARING S 89°E
Thickness of overburden: 0.3'
Depth drilled into rock: 326.8'
Total depth of hole: 327.1'
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B 400
Total no. of overburden samples taken: 0
Total number core boxes: 22
Date hole: 18 AUG., 1964 24 AUG., 1964
Elevation top of hole: 944.0
Total core recovery for boring: 326.3' 99.8%

Elevation	Depth	Classification of materials	% Core Recov.	Box or Sample No.	Remarks
944		MOSS, ORGANIC SILT			NO SAMPLES
		QUARTZ DIORITE-HARD, MED. TO CSE. GRAINED, WHITE & BLACK, LT. WEA.	100	1	CORE LENGTHS TO 1.2' 100% W.R., GRAY
	10		90		CORE LENGTHS TO 5.1'
				14.8	
928	20	DIORITE, MOD. HARD, FINE GRAINED, BLACK, QTZ SEAMS COMMON		2	CORE LENGTHS TO 8.1' 100% W.R., GRAY, GREEN
	30			29.5	
				3	
916	40			44.3	
	50			4	
			100		
	60			58.8	CORE LENGTHS TO 1.0'
					CORE LENGTHS TO 3.5'
				5	
892	70	QTZ DIO. ... MASSIVE, FRESH		73.9	CORE LENGTH TO 9.1' 100% W.R., GRAY
	80			6	
				89.1	
	90			7	CORE LENGTHS TO 1.1'
873	100				

Hole No. DH 15

DRILLING LOG — Division: NORTH PACIFIC — Installation: ALASKA — Sheet 2 of 4 sheets

Project: SNETTISHAM-LONG LAKE D.S.
Location: N 103,708 E 95,614
Drilling agency: CORPS OF ENGINEERS
Name of driller: DON METLER
Direction of hole: 45 BEARING S 89°E
Thickness of overburden: 0.3'
Depth drilled into rock: 326.8'
Total depth of hole: 327.1'
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B 400
Total no. of overburden samples taken: 0 0
Total number core boxes: 22
Date hole: 18 AUG., 1964 24 AUG., 1964
Elevation top of hole: 944.0
Total core recovery for boring: 326.3' 99.8%

Elevation	Depth	Classification of materials	% Core Recov.	Box or Sample No.	Remarks
873		QUARTZ DIORITE AS BEFORE	100	7	CORE LENGTHS TO 2.4' 100% W.R., GRAY
870				104.3	
	110	DIORITE-MOD. HARD, FINE GR. GRAY BLACK, SOMEWHAT FRAC.		8	
			90		CORE LENGTHS TO 0.7' 100% W.R., RED - GRAY
859		STRIATED SLICKS, DIP 73°		119.6	
858	120	FAULT-DIP 80°-VERTICALLY SLICKENSIDED, 1" GOUGE & BRECCIAS OPEN, SOLUTIONED	97		
856					
855		BASALT DIKE HARD, DENSE APHANITIC, GREEN, GRAY TO BLACK, SLICKENSIDED FRAC.	78		100% W.R. BROWN GRAY
850	130		93		CORE LENGTHS TO 2.5'
849		DIORITE-COARSE GR LT. WEA.		135.8	
	140			10	CORE LENGTHS TO 7.4'
837	150	QUARTZ DIORITE-HARD, CSE. GRAINED, WHITE & BLACK, MASSIVE, FRESH		150.4	
	160			11	
				165.3	
	170		100	12	
	180			180.1	
				13	
	190			194.9	
	200			14	

Hole No. DH 15

DRILLING LOG — Division: NORTH PACIFIC — Installation: ALASKA — Sheet 3 of 4 sheets

Project: SNETTISHAM-LONG LAKE D.S.
Location: N 103,708 E 95,614
Drilling agency: CORPS OF ENGINEERS
Name of driller: DON METLER
Direction of hole: ☐ Vertical ☒ Inclined 45 BEARING S 89°E
Thickness of overburden: 0.3
Depth drilled into rock: 326.8'
Total depth of hole: 327.1'
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B 400
Total no. of overburden samples taken: 0 0
Total number core boxes: 22
Date hole: 18 AUG., 1964 24 AUG., 1964
Elevation top of hole: 944.0
Total core recovery for boring: 326.3 99.8%

Elevation	Depth	Classification of materials	% Core Recov.	Box or Sample No.	Remarks
803		QUARTZ DIORITE-HARD, MED. TO CSE. GRAINED, WHITE & BLACK, MASSIVE, FRESH OCCAS. QTZ SEAMS		14	100% W.R., MILKY GRAY CORE LENGTHS TO 10.0'
	210			210.0	
				15	100% W.R., BROWN GRAY
	220				
786		DIORITE-MOD. HARD, FINE TO MED. GRAINED, BLACK & WHITE QTZ SEAMS COMMON		224.3	CORE LENTHS TO 1.9'
	230			16	
	240			239.0	
				17	CORE LENGTHS TO 8.8' 100% ... GRAY
762	250	QUARTZ DIORITE, HARD, QTZ DOMINANT, MED. GRAINED, WHITE & BLACK	100	253.2	
	260			18	
	270			268.0	
				19	
	280			282.7	CORE LENGTHS TO 1.0' 100% ... BROWN CORE LENGTHS TO 10.0'
				20	
	290			297.4	
733	300			21	

DRILLING LO
SNETT
N 103
733
310
320
712.7 327.1

U. S. ARMY

DRILLING LOG — Hole No. DH 15 (Sheet 1 of 2 sheets)

Division: NORTH PACIFIC — Installation: ALASKA

Project: SNETTISHAM LONG LAKE D.S.
Location: N 103,088 E 95,250
Drilling agency: CORPS OF ENGINEERS
Name of driller: DON METLER
Direction of hole: Inclined 55 — BEARING S 10° W
Thickness of overburden: 2.4'
Depth drilled into rock: 192.0'
Total depth of hole: 194.4'
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B 401
Total no. of overburden samples taken: 0 0
Total number core boxes: 13
Date hole: Started 12 AUG., 64 — Completed 20 AUG., 64
Elevation top of hole: 865.4
Total core recovery for boring: 190.9' 99.4%

Depth	Classification of materials	% core recovery	Box or sample no.	Remarks
	SANDY SILT, ORGANIC, BROWN			NOT SAMPLED
	QUARTZ DIORITE HARD, MEDIUM TO COARSE GRAINED, BLACK & WHITE, LT. WEA.	98		CORE LENGTHS TO 0.6'
10			1	100% W.R. GREEN, BROWN AND GRAY
				CORE LENGTHS TO 3.7'
20		100	17.3	
			2	
30			31.4	
		94	3	← LOST DRILL WATER RETURN
40		100		
	DIORITE, MOD. HARD, FINE GRAINED, BLACK		47.4	
50		85		CORE LENGTHS TO 0.4'
			4	CORE LENGTHS TO 7.1'
60			62.7	
70			5	CORE LENGTHS TO 2.9'
80		100	77.4	
			6	
90			91.9	
100			7	

DRILLING LOG — Hole No. DH 15 (Sheet 2 of 2 sheets)

Division: NORTH PACIFIC — Installation: ALASKA

Project: SNETTISHAM LONG LAKE D.S.
Location: N 103,088 E 95,250
Drilling agency: CORPS OF ENGINEERS
Name of driller: DON METLER
Direction of hole: Inclined 55 — BEARING S 10°W
Thickness of overburden: 2.4'
Depth drilled into rock: 192.0'
Total depth of hole: 194.4'
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B 401
Total no. of overburden samples taken: 0 0
Total number core boxes: 13
Date hole: Started 12 AUG., 1964 — Completed 20 AUG., 1964
Elevation top of hole: 865.4'
Total core recovery for boring: 190.9' 99.4%

Elevation	Depth	Classification of materials	% core recovery	Box or sample no.	Remarks
807		QUARTZ DIORITE (AS BEFORE)			NO WATER RETURN
				7	CORE LENGTHS TO 3.7'
				105.6	CORE LENGTHS TO 0.6'
	110			8	CORE LENGTHS TO 1.9'
					CORE LENGTHS TO 1.0'
	120	QUARTZ DIORITE, MASSIVE, FRESH		121.0	CORE LENGTHS TO 2.2'
				9	CORE LENGTHS TO 10.0'
	130			135.0	
	140		100	10	
	150			150.5	
	160			11	
				165.0	
	170			12	
	180			180.0	
	190			13	
753.9'		TRUE VERTICAL DEPTH 111.5'			
	200	TRUE HORIZONTAL DEPTH 169.2'			

DRILLING LOG — Hole No. DH 16 (Sheet 4 of 4 sheets)

Division: NORTH PACIFIC — Installation: ALASKA

Project: SNETTISHAM - LONG LAKE D.S.
Location: [N 1]03,708 E 95,514
Drilling agency: CORPS OF ENGINEERS
Name of driller: DON METLER
Direction of hole: Inclined 45 — BEARING S 89°E
Thickness of overburden: 0.3'
Depth drilled into rock: 326.8'
Total depth of hole: 327.1'
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B 400
Total no. of overburden samples taken: 0 0
Total number core boxes: 22
Date hole: Started 18 AUG., 1964 — Completed 24 AUG., 1964
Elevation top of hole: 944.0'
Total core recovery for boring: 326.3' 99.8%

Classification of materials	% core recovery	Box or sample no.	Remarks
DIORITE - MOD. HARD, FINE TO MED. GRAINED, BLACK, MASSIVE, FRESH			CORE LENGTHS TO 8.3' 100% BROWN GRAY WATER RETURN
		21	
	100	312.2	
		22	CORE LENGTHS TO 2.9'

BOTTOM OF HOLE EL. 712.7'
TRUE VERTICAL DEPTH 231.3'
HORIZONTAL DISTANCE 231.3'
DEPTH OF HOLE 327.1'
THICKNESS OF O. B. 0.3'
ROCK CORED 326.8'
CORE RECOVERED 326.3'

NOTE:
SEE LOG RECORDS NUMBER 1 FOR NOTES AND LEGEND

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: W. D. Trautwein
DRAWN: W. D. Trautwein
CHECKED: W. G. Binkley
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORD NO. 3

SUPERVISED: M. A. Dixon — CHIEF, GEOLOGY SECTION
APPROVED: Clare F. Farley — COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: — CHIEF, FOUNDATIONS & MATERIALS BRANCH
SCALE — DATE 20 Oct 60 — FILE NUMBER
RECOMMENDED: Warren George — CHIEF, ENGINEERING DIVISION
SHEET OF

2

CORPS OF ENGINEERS

DRILLING LOG — Hole No. DH 17 (Sheet 1 of 2 sheets)

Division: NORTH PACIFIC — Installation: ALASKA

Project: SNETTISHAM-LONG LAKE D.S.
Location: N 103,099 E 95,248
Drilling agency: CORPS OF ENGINEERS
Name of driller: DON METLER
Direction of hole: Inclined 55, BEARING N 6° E
Size and type of bit: NX
Manufacturer's designation of drill: JOY 12 B, 401
Total no. of overburden samples taken: 0, 0
Total number core boxes: 12
Date hole: 21 AUG., 1964 — 25 AUG., 1964
Elevation top of hole: 865.7'
Total core recovery for boring: 172.6' 97.3%
Thickness of overburden: 1.0'
Depth drilled into rock: 177.4'
Total depth of hole: 178.4'

Elevation 866 / 865

- MOSS, ORGANIC SILT — NOT SAMPLED
- QUARTZ DIORITE, HARD, CSE. GRAINED, WHITE & BLACK, LT. WEA. — 100 — 1 — 100% W.R., GRAY CORE LENGTHS TO 2.1'
- 98 — 15.6
- 97 — 2 — 80% W.R., GRAY CORE LENGTHS TO 5.2'
- 849 — 30.4 — 70% W.R., GRAY LOST DRILL WATER CORE LENGTHS TO 0.9' W.T. EL. 847'
- 846 — BASALT-HARD, DENSE, APHANITIC, BLACK, FRAC. — 76, 90
- 844, 843 — QTZ DIO, MED. GRAINED, QTZ. DOMINANT, MASSIVE, FRESH — 87, 97 — 3 — CORE LENGTHS TO 5.6'
- 46.4
- 100 — 4
- 61.4 — CORE LENGTHS TO 2.5'
- 5 — CORE LENGTHS TO 7.1'
- 76.1
- 6
- 90.8
- 95 — 7
- 808 — 100

DRILLING LOG — Hole No. DH 17 (Sheet 2 of 2 sheets)

Division: NORTH PACIFIC — Installation: ALASKA
Project: SNETTISHAM-LONG LAKE D.S. — N 103,099 E 95,248 — CORPS OF ENGINEERS — DON METLER — 55, BEARING N 6° E — NX — JOY 12 B, 401 — 0, 0 — 12 — 21 AUG., 1964 25 AUG., 1964 — 865.7' — 172.6' 97.3% — 1.0' — 177.4' — 178.4'

Elevation 808

- QUARTZ DIORITE HARD, MED. TO CSE. GRAINED, WHITE & BLACK, QTZ DOMINANT — 100 — 7 — CORE LENGTHS TO 10.1' NO WATER RETURN
- 105.2 — 8
- 120.5
- 98 — 9
- 798 — QTZ DIO. MOD HARD, MOD WEA., RUST STAINED RED, BROWN & YELLOW CLAY COATINGS ON FRACTURING — 92 — 135.4 — CORE LENGTHS TO 0.9'
- 90 — 10
- 151.4
- 777 — QTZ DIO, HARD, CSE GRAINED, WHITE & BLACK, LT. WEA. — 100 — CORE LENGTHS TO 1.7'
- 11
- 97 — 165.9 — CORE LENGTHS TO 6.8'
- 100 — 12
- 764 — 180

BOTTOM OF HOLE EL. 764.0'
TRUE VERTICAL DEPTH 101.7'
HORIZONTAL DISTANCE 145.3'
DEPTH OF HOLE 178.4'
THICKNESS OF O.B. 1.0'
ROCK CORED 177.4'
CORE RECOVERED 172.6'
% CORE RECOVERY 97.3

DRILLING LOG — Hole No. DH 18 (Sheet 1 of 7)

Division: NORTH PACIFIC — Installation: ALASKA
Project: SNETTISHAM-TUNNEL-FAULTS 1 & 2
Location: N 101,840 E 94,056
Drilling agency: CORPS OF ENGINEERS
Hole no.: DH 18
Name of driller: POOLE, CURTIS, BURGESS
Direction of hole: 40, BEARING N 20° W
NX — JOY 12 B, 400 — 0, 0 — 38
Elevation ground water: -130.0, 1693.1
Date hole: 28 AUG., 1964 — 10 SEP., 1964
Elevation top of hole: 1792.6'
Total core recovery: 553.7' 91.3%
0.0 — 605.5' — 605.5'

Elevation 1793

- QUARTZ DIORITE: HARD; MED. TO CSE. GRAINED; LT. WEA.; RUST STAINED; BLACK & WHITE GNEISSIC BANDING; FRACTURED. — 1 — CORE LENGTHS TO 0.7' 100% W.R., GRAY BROWN
- 100 — 13.9 — CORE LENGTHS TO 3.9'
- 2
- 28.8
- 1763 — QTZ. — CL. FRAC., HI. CORE LOSS SOFT SEAMS — 79 — 3 — CORE LENGTHS TO 1.2' VERY SOFT DRILLING GROUND PARTINGS
- 92 — 45.6 — CORE LENGTHS TO 2.2' 100-90% GRAY W.R. CORE LENGTHS TO 0.8'
- 1755 — 100 — 4 — CORE LENGTHS TO 1.8'
- 1748, 1744 — CL. FRACT., RUST STAINED — 73 — CORE LENGTHS TO 1.0' 90% W.R., GRAY
- 62.3 — CORE LENGTHS TO 2.9'
- CORE LENGTHS TO 1.1'
- 100 — 5 — 90-80% W.R., GRAY BROWN
- 77.4 — CORE LENGTHS TO 1.8' 80-70% W.R., GRAY BROWN
- 1730, 1727 — FRAC., MOD HARD, RUST STAINED — 98 — 6 — CORE LENGTHS TO 2.3'
- 100 — 92.3 — 7
- 1716 — 100 — CL. FRAC., SLICKS MOD WEA. — 75

DRILLING LOG — Hole No. DH 18 (Sheet 4 of 7)

Division: NORTH PACIFIC — Installation: ALASKA
Project: SNETTISHAM-LONG LAKE TUNNEL-FAULTS — N 101,840 E 94,056 — CORPS OF ENGINEERS — DH 18 — CURTIS, POOLE — 40, BEARING N 20°W — NX — JOY 12 B, 400 — 0, 0 — 38 — -130.0, 1693.1' — 28 AUG., 1964 10 SEP., 1964 — 1792.6' — 553.7' 91.3% — 0.0 — 605.5' — 605.5'

Elevation 1593

- QUARTZ DIORITE: HARD; WHITE AND BLACK; MED. TO COARSE GRAINED; LT. WEA.; SOMEWHAT FRACT. — 100 — 19 — CORE LENGTHS TO 1.8' 90% W.R., BROWN GRAY
- 307.5
- DIORITE: MOD. HARD; MED. GRAINED; BLACK AND WHITE. — 20 — CORE LENGTHS TO 3.9'
- 321.7
- 21 — 50% W.R., BROWN
- 1538, 1535 — DIORITE: MOD. HARD; MED. GRAINED; BLACK AND WHITE; CL. FRACT. — 97 — 336.7 — CORE LENGTHS TO 1.4' GROUND PARTINGS
- 100 — CORE LENGTHS TO 8.4'
- RANDOM QTZ. SEAMS — CORE LENGTHS TO 1.0' 90% W.R., BROWN GRAY
- FRAC. — 22 — CORE LENGTHS TO 4.3'
- 351.8
- CORE LENGTHS TO 1.1'
- FRACTURE ZONES — 23 — CORE LENGTHS TO 2.5' CORE LENGTHS TO 1.2'
- 366.3 — CORE LENGTHS TO 4.3'
- 1507 — BASALT: HARD; DENSE; APHANITIC; SLICKENSIDED CONTACTS. — 24 — CORE LENGTHS TO 10.0'
- 381.9
- 1499 — QUARTZ DIORITE: HARD; MED. GRAINED; MASSIVE; FRESH; DIORITE INCLUSIONS COMMON.
- 25
- 395.6' — 26

DRILLING LOG — Hole No. DH 18 (Sheet 5 of 7)

Division: NORTH PACIFIC — Installation: ALASKA
Project: SNETTISHAM-LONG LAKE TUNNEL-FAULTS — N 101,840 E 94,056 — CORPS OF ENGINEERS — DH 18 — POOLE, BURGESS — 40, BEARING N 20° W — NX — JOY 12 B, 400 — 0, 0 — 38 — -130.0, 1693.1 — 28 AUG., 1964 10 SEP., 1964 — 1792.6' — 553.7' 91.3% — 0.0 — 606.5' — 606.5'

Elevation 1486

- QUARTZ DIORITE (AS ABOVE) — 26 — CORE LENGTHS TO 1.8' 50-60% W.R., GRAY CORE LENGTHS TO 1.0'
- 100 — 410.2
- 1475, 1474 — FRAC., RUST STAINED, MOD. WEA. — 27
- BASALT: HARD; DENSE; APHANITIC; BLACK. — 63 — CORE LENGTHS TO 1.2' 90% W.R., GRAY
- 1465, 1463 — CL. FRAC., MOD. SOFT SEAMS, WEATHERED — 95 — 426.5 — CORE LENGTHS TO 2.3' 80% W.R., GRAY
- 1459, 1458 — 28
- 100 — CORE LENGTHS TO 8.1' 50-60% W.R., BROWN
- DIORITE SEAMS — 442.9
- 99 — 29
- 457.8
- 30 — 20-30% W.R., BROWN GRAY
- 100
- QTZ. — 472.7
- 1425, 1421 — QTZ. — CL. FRAC., MOD. WEA. — 31 — CORE LENGTHS TO 0.5' 20% W.R., BROWN GRAY
- 1416 — BASALT: HARD; DENSE; FRAC; APHANITIC; BLACK. — 76 — 488.7 — CORE LENGTHS TO 1.1'
- 1414, 1411 — QTZ. DIKE: HARD; WHITE, GRAY, GREEN & BLACK; CHEM. ALT. — 100 — 32 — CORE LENGTHS TO 2.7' 10% W.R., GRAY
- 1410 — 500 — DIORITE: MOD. HARD, MED. GR.

DRILLING LOG — Hole No. DH 18 (Sheet 6 of 7)

Division: NORTH PACIFIC — Installation: ALASKA
Project: SNETTISHAM-LONG LAKE TUNNEL-FAULTS — N 101,840 E 94,056 — CORPS OF ENGINEERS — DH 18 — POOLE, BURGESS — 40, BEARING N 20° W — NX — JOY 12 B, 400 — 0, 0 — 38 — -130.0, 1693.1' — 28 AUG., 1964 10 SEP., 1964 — 1792.6' — 553.7' 91.3% — 0.0 — 605.5' — 605.5'

Elevation 1410

- DIORITE: MOD. HARD; FINE TO MED GRAINED; BLACK & WHITE. — 100 — 32 — CORE LENGTHS TO 2.9' 30-20% W.R., GRAY
- QTZ. DIORITE, HARD — 99 — 504.8 — CORE LENGTHS TO 1.0'
- SLICKENSIDED FRACTURING COMMON — 98, 67 — 33 — 20-10% W.R., GRAY
- 100 — 520.4
- 1388 — ZONE OF SHATTERING, SLICKENSIDED FRAGMENTS PROBABLE FAULT — 76 — 34
- 1381 — 35 — CORE LENGTHS TO 2.6'
- 81 — 540.0 — 20% W.R., BROWN GRAY CORE LENGTHS TO 1.0'
- 1377 — CL. FRAC. — QTZ. DIKE, HARD, FRAC — 36
- 1370, 1369 — SLICKS — 71 — 15% W.R., BROWN
- 1367 — BASALT: HARD; DENSE; APHANITIC; BROWN-BLACK; VERY CL. FRAC. — SLICKS — 556.1
- 1363 — QUARTZ DIORITE: HARD, MED. GRAINED, WHITE AND BLACK CL. FRAC., SLICKS COMMON — 100 — 36 — CORE LENGTHS TO 2.0' 30% W.R., GRAY
- 1359 — 94 — CORE LENGTHS TO 1.0' 30-40% W.R., GRAY CORE LENGTHS TO 0.5'
- 1355 — BASALT (AS ABOVE) — 573.7 — CORE LENGTHS TO 2.8' 10% W.R., BROWN GRAY
- 1352 — SLICKS, BRECCIA — 89
- 37 — CORE LENGTHS TO 0.5'
- 1347 — FIRST FAULT — 30 — 37
- 1342 — SHEAR ZONE
- 1339 — BASALT FRAGMENTS — 95 — 592.9 — CORE LENGTHS TO 1.0' 30% W.R., BROWN GRAY
- 1335, 1333 — 600 — CHEM. ALT. DIORITE — 99 — 38

DRILLING LOG — Hole No. DH 18 (Sheet 2 of 7 sheets)

DIVISION	NORTH PACIFIC
INSTALLATION	ALASKA
PROJECT	SNETTISHAM LONG LAKE TUNNEL FAULTS 1 & 2
LOCATION	N 101,840 E 94,056
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO.	DH 18
NAME OF DRILLER	AARON CURTIS, H.O. POOLE
DIRECTION OF HOLE	40 BEARING N 20° W
THICKNESS OF OVERBURDEN	0.0
DEPTH DRILLED INTO ROCK	606.5'
TOTAL DEPTH OF HOLE	606.5'
SIZE AND TYPE OF BIT	NX
MANUFACTURER'S DESIGNATION OF DRILL	JOY 12 B
TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	400 / 0 / 0
TOTAL NUMBER CORE BOXES	38
ELEVATION GROUND WATER	130.0' / 1693.1'
DATE HOLE	STARTED 28 AUG. 1964 / COMPLETED 10 SEP. 1964
ELEVATION TOP OF HOLE	1792.6'
TOTAL CORE RECOVERY FOR BORING	553.7' / 91.3%

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
1716					
1715		QUARTZ DIORITE (AS BEFORE)			CORE LENGTHS TO 1.6'
1711		SHEAR ZONE, SLICKS, MOD SOFT, CRUMBLY, CL FRAC., HI. WEA., BROWN	75	7	2ND FAULT 90% W.R., BROWN
1705	110			108.8	
1703		CL FRAC., HI CORE LOSS GROUND PARTINGS	69		GROUND PARTINGS
				8	CORE LENGTHS TO 2.7'
	120				
1695				126.5	CORE LENGTHS TO 1.6' 75% BROWN GRAY W.R.
1693	130	MOD WEA., CL FRAC.		9	
1691					
1690			100		
	140	QTZ		141.0	CORE LENGTHS TO 1.0' 95% W.R. BROWN
				10	CORE LENGTHS TO 2.4'
	150				
				156.3	CORE LENGTHS TO 1.0'
1671	160	ZONE OF CLOSE FRAC., HI. CORE LOSS	85		
				11	
	170				
1661		BASALT: HARD, APHANITIC; DENSE; BLACK TO GRAY	87 / 95	177.3	
	180		88		
		BASALT: SOFT; DARK BROWN; MOD ALT.; HI. CORE LOSS; PROBABLE FAULT.		12	
	190	QUARTZ DIORITE, CL FRAC., MOD WEA., RUST STAINED			
		ZONE OF SLICKS	100		
	200	QTZ. DIO., HARD, WHITE & BLACK			

DRILLING LOG — Hole No. DH 18 (Sheet 3 of 7 sheets)

DIVISION	NORTH PACIFIC
INSTALLATION	ALASKA
PROJECT	SNETTISHAM LONG LAKE TUNNEL FAULTS
LOCATION	N 101,840 E 94,056
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO.	DH 18
NAME OF DRILLER	AARON CURTIS, H.O. POOLE
DIRECTION OF HOLE	40 BEARING N 20° W
THICKNESS OF OVERBURDEN	0.0'
DEPTH DRILLED INTO ROCK	606.5'
TOTAL DEPTH OF HOLE	606.5'
SIZE AND TYPE OF BIT	NX
MANUFACTURER'S DESIGNATION OF DRILL	JOY 12 B
TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	400 / 0 / 0
TOTAL NUMBER CORE BOXES	38
ELEVATION GROUND WATER	130.0
DATE HOLE	STARTED 28 AUG. 1964 / COMPLETED 10 SEPT. 1964
ELEVATION TOP OF HOLE	1792.6'
TOTAL CORE RECOVERY FOR BORING	553.7' / 91.3%

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
1640		QUARTZ DIORITE (AS BEFORE)	100	201	CORE LENGTHS TO 1.4' 90-75% W.R., BROWN GRAY
	210		99	13	CORE LENGTHS TO 3.4'
1628		CLOSE SLICKENSIDED FRACTURING.	80	215.6	CORE LENGTHS TO 0.7' 70% W.R., GRAY
1623	220	HI. CORE LOSS, HI. WEA., SOFT CLAY; PROBABLE FAULT.			
1621				14	
1617	230				CORE LENGTHS TO 2.8'
				232.5	100% W.R., GRAY
	240			15	
			100	247.4	
	250	QUARTZ DOMINANT ZONE			
				16	
	260			262.2	
	270		97	17	
1584		FRACT.			CORE LENGTH TO 1.0'
1582		QTZ., CL FRAC.			90% W.R., BROWN GRAY
1580		POSSIBLE FAULT, HI. CORE LOSS	62	278.6	
1576	280	QTZ			
1575				18	CORE LENGTHS TO 6.0'
	290		100		
				293.2	
				19	
1563	300				

DRILLING LOG — Hole No. DH 18 (Sheet 7 of 7 sheets)

DIVISION	NORTH PACIFIC
INSTALLATION	ALASKA
PROJECT	SNETTISHAM - LONG LAKE TUNNEL - FAULTS
LOCATION	N 101,840 E 94,056
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO.	DH 18
NAME OF DRILLER	POOLE, CURTIS, BURGESS
DIRECTION OF HOLE	40 BEARING N 20° W
THICKNESS OF OVERBURDEN	0.0
DEPTH DRILLED INTO ROCK	606.5'
TOTAL DEPTH OF HOLE	606.5'
SIZE AND TYPE OF BIT	NX
MANUFACTURER'S DESIGNATION OF DRILL	JOY 12 B
TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	400 / 0 / 0
TOTAL NUMBER CORE BOXES	38
ELEVATION GROUND WATER	-130.0 / 1693.1
DATE HOLE	STARTED 28 AUG. 1964 / COMPLETED 10 SEP. 1964
ELEVATION TOP OF HOLE	1792.6'
TOTAL CORE RECOVERY FOR BORING	553.7' / 91.3%

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
	605.5	QUARTZ DIORITE (AS BEFORE)	99	38	30% W.R., BROWN GRAY CORE LENGTHS TO 2.2'

BOTTOM OF HOLE	1328.0
VERTICAL DEPTH	464.6
HORIZONTAL DISTANCE	389.9
DEPTH OF HOLE	606.5
THICKNESS OF O.B.	0.0
ROCK CORED	605.5
CORE RECOVERED	553.7
% CORE RECOVERY	91.3

NOTE:
SEE LOG RECORDS NUMBER 1 FOR NOTES AND LEGEND

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE ALASKA

DESIGNED: Wm. B. Trentwain
DRAWN: Wm. B. Trentwain
CHECKED: W.G. Binkley
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORD NO. 4

SUPERVISED: M. Dixon — CHIEF, GEOLOGY SECTION
SUBMITTED: CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

CORPS OF ENGINEERS

DRILLING LOG — Hole No. DH 19 — Sheet 1 of 4 sheets

- Division: NORTH PACIFIC
- Installation: ALASKA (NPA)
- 1. Project: SNETTISHAM LONG LAKE TUNNEL PORTAL
- 2. Location: N 103,282 E 94,797
- 3. Drilling agency: CORPS OF ENGINEERS
- 5. Name of driller: DON METLER
- 6. Direction of hole: Inclined 30, BEARING N 49°W
- 7. Thickness of overburden: 9.5'
- 8. Depth drilled into rock: 322.8'
- 9. Total depth of hole: 332.3'
- 10. Size and type of bit: NX, BX
- 12. Manufacturer's designation of drill: JOY 12 B 401
- 13. Total no. of overburden samples taken: 0 / 0
- 14. Total number core boxes: 18
- 16. Date hole: Started 31 AUG. 64 — Completed 18 SEPT. 64
- 17. Elevation top of hole: 832.7'
- 18. Total core recovery for boring: 322.7' 99.9%

Elevation	Depth	Classification of Materials	% Core Recov	Box or Sample No.	Remarks
833		TALUS: BLOCKY BOULDERS IN SILTY BROWN ORGANIC SOIL			LOCATED AT BASE OF 500' HIGH CLIFFS-SET UP DUG 15' WIDE, 18' LONG WITH BANK 15' HIGH AT BACK OF DUG OUT
824	10	DIORITE-MOD. HARD, FINE TO MED. GR., BLACK & WHITE, LT. WEA.		11.0	NX CORE-DISCARDED AS IT DOES NOT FIT BX CORE BOXES
819	20	QUARTZ DIORITE-HARD MED. TO CSE. GR. WHITE & BLACK		1	100% W.R., GRAY CORE LENGTHS TO 10.0'
	30			28.6	
	40			2	CORE LENGTHS TO 3.5'
	50		100	47.0	
				3	
779 / 777	60	BASALT-HARD, DENSE, APHANITIC, BLACK, CL. FRAC., LT. WEA.,			LOST DRILL WATER
	70			66.2	
	80			4	CORE LENGTHS TO 7.5'
	90			84.7	
				5	
746	100				

DRILLING LOG — Hole No. DH 19 — Sheet 2 of 4 sheets

- Division: NORTH PACIFIC
- Installation: ALASKA (NPA)
- 1. Project: SNETTISHAM LONG LAKE TUNNEL PORTAL
- 2. Location: N 103,282 E 94,797
- 3. Drilling agency: CORPS OF ENGINEERS
- 5. Name of driller: METLER, DUPUIS
- 6. Direction of hole: Inclined 30, BEARING N 49°W
- 7. Thickness of overburden: 9.5'
- 8. Depth drilled into rock: 322.8'
- 9. Total depth of hole: 332.8'
- 10. Size and type of bit: BX, NX
- 12. Manufacturer's designation of drill: JOY 12 B 401
- 13. Total no. of overburden samples taken: 0 / 0
- 14. Total number core boxes: 18
- 16. Date hole: Started 31 AUG., 1964 — Completed 18 SEPT., 1964
- 17. Elevation top of hole: 832.7'
- 18. Total core recovery for boring: 322.7' 99.9%

Elevation	Depth	Classification of Materials	% Core Recov	Box or Sample No.	Remarks
746		QUARTZ DIORITE (AS BEFORE) LT. WEA., O'CAS. RUST STAINED OPEN FRACTURES		5 / 102.6'	NO WATER RETURN CORE LENGTHS TO 2.8'
	110			6	CORE LENGTHS TO 0.5' CORE LENGTHS TO 3.0'
727	120	BASALT DIKE - HARD, DENSE, VERY FINE GR., GRAY TO BROWN BLACK, CL. FRAC. SOMEWHAT FRACTURED		120.8'	CORE LENGTHS TO 0.8'
724				7	CORE LENGTHS TO 1.8'
	130				CORE LENGTHS TO 3.0'
	140			138.8'	CORE LENGTHS TO 0.9'
				8	
	150		100		
	160			157.0'	CORE LENGTHS TO 4.0' 0-10% W. R., GRAY
		QUARTZ DIORITE, MASSIVE, FRESH		9	
	170				10-20% W. R., GRAY
	180			174.2'	CORE LENGTHS TO 9.8' 20-30% W. R., GRAY
	190			10	30-50% W. R., GRAY
				192.9'	
				11	20-0% W. R., GRAY
660	200				

DRILLING LOG — Hole No. DH 19 — Sheet 3 of 4 sheets

- Division: NORTH PACIFIC
- Installation: ALASKA (NPA)
- 1. Project: SNETTISHAM LONG LAKE TUNNEL PORTAL
- 2. Location: N 103,282 E 94,797
- 3. Drilling agency: CORPS OF ENGINEERS
- 5. Name of driller: DON DUPUIS
- 6. Direction of hole: Inclined 30, BEARING N 49°W
- 7. Thickness of overburden: 9.5'
- 8. Depth drilled into rock: 322.8'
- 9. Total depth of hole: 332.3'
- 10. Size and type of bit: NX, BX
- 12. Manufacturer's designation of drill: JOY 12 B 401
- 13. Total no. of overburden samples taken: 0 / 0
- 14. Total number core boxes: 18
- 16. Date hole: Started 31 AUG., 1964 — Completed 18 SEPT., 1964
- 17. Elevation top of hole: 832.7'
- 18. Total core recovery for boring: 322.7' 99.9%

Elevation	Depth	Classification of Materials	% Core Recov	Box or Sample No.	Remarks
660		QUARTZ DIORITE (AS BEFORE) MASSIVE, FRESH			0-20% W.R., GRAY INTERMITTENT
				11	CORE LENGTHS TO 10.0'
	210			211.2	
	220			12	
636	230	DIORITE-MOD. HARD, FINE TO MED. GR., GLACK & WHITE, MASSIVE, FRESH		229.6	CORE LENGTHS TO 1.9'
	240			13	
	250		100	247.6	CORE LENGTHS TO 3.8'
613 / 611 / 609		FAULT-GOUGE, SOFT, ALTERED, RUST BROWN, CALCITE LINED VUGS, SLICKS DIPPING 5?°-60° MOD. HARD, FINE GR., GRAY		14	CORE LENGTHS TO 0.5' 10-30% W.R., GRAY CORE LENGTHS TO 2.5'
	260	QUARTZ DIORITE-HARD CSE. GR., WHITE & BLACK		265.6	20-40% W.R., GRAY CORE LENGTHS TO 9.9'
	270			15	CORE LENGTHS TO 3.4' 20-30% W.R., GRAY
	280			283.9	CORE LENGTHS TO 6.4' 10-0% W.R., GRAY
	290			16	CORE LENGTHS TO 1.8' 0-20% W.R., GRAY
573	300				

DRILLING LOG — Hole No. DH 20 — Sheet 2 of 8 sheets

- Division: NORTH PACIFIC
- Installation: ALASKA
- 1. Project: SNETTISHAM - MID PENSTOCK -DOWNHOLE
- 2. Location: N 95,494 E 92,617
- 3. Drilling agency: CORPS OF ENGINEERS
- 4. Hole No.: DH 20
- 5. Name of driller: VERMULLEN
- 6. Direction of hole: Inclined 30, BEARING S 47° E
- 7. Thickness of overburden: 3.3'
- 8. Depth drilled into rock: 752.1'
- 9. Total depth of hole: 755.4'
- 10. Size and type of bit: NX, BX, BXW
- 12. Manufacturer's designation of drill: JOY 12 B 400
- 13. Total no. of overburden samples taken: 0 / 0
- 14. Total number core boxes: 39
- 16. Date hole: Started 16 SEPT., 1964 — Completed 16 OCT., 1964
- 17. Elevation top of hole: 581.1'
- 18. Total core recovery for boring: 748.6' 99.53%

Elevation	Depth	Classification of Materials	% Core Recov	Box or Sample No.	Remarks
495		DIORITE & QTZ. DIORITE (AS BEFORE)			95% W.R., BROWN GRAY CORE LENGTHS TO 5.9'
489		CORKSCREW FRACTURING		7	CORE LENGTHS TO 0.8'
	110				CORE LENGTHS TO 7.5'
		FRACTURES		117.2	CORE LENGTHS TO 1.4' 95%-100% W.R., GRAY
	120	CORKSCREW FRACTURING			
471		CLOSE CORKSCREW FRAC.; MOD. SOFT; LT. WEA.; POSSIBLE FAULT ZONE		8	CORE LENGTHS TO 0.3'
	130				CORE LENGTHS TO 10.0'
				134.3	
	140			9	
	150		100		
		FRACTURED		152.8	CORE LENGTHS TO 2.8'
	160	0.1' BASALT SEAM		10	
437		BASALT: HARD, DENSE, BLACK, APHANITIC, FRAC.,			
	170			170.9	
428		FRACTURED			CORE LENGTHS TO 0.5'
425	180	SLICKS, YELLOW CLAY COATING,		11	CORE LENGTHS TO 2.3'
		FRACTURED			
418	190	BASALT: HARD, DENSE, BLACK		189.2	CORE LENGTHS TO 10.0'
				12	
408	200				

DRILLING LOG — Hole No. DH 20 — Sheet 3 of 8 sheets

- Division: NORTH PACIFIC
- Installation: ALASKA
- 1. Project: SNETTISHAM - MID PENSTOCK- DOWN HOLE
- 2. Location: N 95,494 E 92,617
- 3. Drilling agency: CORPS OF ENGINEERS
- 4. Hole No.: DH 20
- 5. Name of driller: VERMULLEN
- 6. Direction of hole: Inclined 30, BEARING S 47° E
- 7. Thickness of overburden: 3.3'
- 8. Depth drilled into rock: 752.1'
- 9. Total depth of hole: 755.4'
- 10. Size and type of bit: NX, BX, BXW
- 12. Manufacturer's designation of drill: JOY 12 B 400
- 13. Total no. of overburden samples taken: 0 / 0
- 14. Total number core boxes: 39
- 16. Date hole: Started 16 SEPT., 1964 — Completed 16 OCT., 1964
- 17. Elevation top of hole: 581.1'
- 18. Total core recovery for boring: 748.6' 99.53%

Elevation	Depth	Classification of Materials	% Core Recov	Box or Sample No.	Remarks
428		DIORITE AND QUARTZ DIORITE: HARD; MED. GR.; BLACK AND WHITE GNEISSIC BANDING.		12	95% W.R., BROWN GRAY CORE LENGTHS TO 4.3'
				207.9'	CORE LENGTHS TO 10.0'
	210			13	
	220			226.0	
	230			14	
	240	0.1' MOD. SOFT BLACK SEAM		244.4'	
363	250	CLOSE FRACTURING, PROBABLE FAULT ZONE	100	15	CORE LENGTHS TO 0.3'
358				259.1	CORE LENGTHS TO 7.4'
	260				
	270	QTZ SEAMS COMMON		16	95% W.R., MILKY WHITE CORE LENGTHS TO 0.5'
341		CONTACT ZONE, CHEM. ALT.		277.4	
338	280	BASALT: HARD; DENSE; BROWN TO GREEN GRAY; APHANITIC; CL. FRAC.			CORE LENGTHS TO 2.4'
		QTZ SEAMS COMMON		17	CORE LENGTHS TO 10.0'
	290			295.6	
321	300			18	

DRILLING LOG — Hole No. DH 20 — Sheet 4 of 8 sheets

- Division: NORTH PACIFIC
- Installation: ALASKA
- 1. Project: SNETTISHAM - MID PENSTOCK- DOWN HOLE
- 2. Location: N 95,494 E 92,617
- 3. Drilling agency: CORPS OF ENGINEERS
- 4. Hole No.: DH 20
- 5. Name of driller: VERMULLEN
- 6. Direction of hole: Inclined 30, BEARING S 47° E
- 7. Thickness of overburden: 3.3'
- 8. Depth drilled into rock: 752.1'
- 9. Total depth of hole: 755.4'
- 10. Size and type of bit: NX, BX, BXW
- 12. Manufacturer's designation of drill: JOY 12 B 400
- 13. Total no. of overburden samples taken: 0 / 0
- 14. Total number core boxes: 39
- 16. Date hole: Started 16 SEPT., 1964 — Completed 16 OCT., 1964
- 17. Elevation top of hole: 581.1'
- 18. Total core recovery for boring: 748.6' 99.53%

Elevation	Depth	Classification of Materials	% Core Recov	Box or Sample No.	Remarks
321		DIORITE AND QTZ. DIORITE (AS BEFORE)			CORE LENGTHS TO 5.5' 95% W.R., BROWN GRAY
		FRACTURED		18	
	310				CORE LENGTHS TO 7.5'
				313.8	
	320	QTZ		19	90% W.R., BROWN GRAY TO CLEAR
	330			332.5	CORE LENGTHS TO 10.0'
	340	QTZ		20	
	350		100	350.9	
	360			21	
	370			369.3	
	380			22	
				388.0	
	390			23	CHANGED OVER TO BW - WIRE LINE CORING
235	400				

DRILLING LOG — Hole No. DH 19

Division	NORTH PACIFIC
Installation	ALASKA (NPA)
Sheet	4 of 4 sheets
Project	SNETTISHAM LONG LAKE TUNNEL PORTAL
Location	N 103,282 E 94,791
Drilling agency	CORPS OF ENGINEERS
Name of driller	DON DUPUIS
Direction of hole	Inclined 30, BEARING N 49°W
Thickness of overburden	9.5'
Depth drilled into rock	322.8'
Total depth of hole	332.3'
Size and type of bit	NX, BX
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	Disturbed 0, Undisturbed 0
Total number core boxes	18
Date hole	Started 31 AUG., 1964; Completed 18 SEPT., 1964
Elevation top of hole	832.7'
Total core recovery for boring	322.7' 99.9 %

Elevation	Depth	Classification of materials	% Core recov-ery	Box or sample no.	Remarks
833		QUARTZ DIORITE (AS BEFORE)	100	302.1	CORE LENGTHS TO 8.2'; 0-30% W.R., GRAY
	310		99	17	
			100		CORE LENGTHS TO 3.7'
	320			320.6	20-30% W.R., GRAY
				18	
	330				
500.9	332.8			332.8	

BOTTOM OF HOLE EL.	544.9'
VERTICAL DEPTH	287.8'
HORIZONTAL DISTANCE	166.2'
DEPTH OF HOLE	332.3'
THICKNESS OF O.B.	9.5'
ROCK CORED	322.8'
CORE RECOVERED	322.7'
% CORE RECOVERY	99.9'

DRILLING LOG — Hole No. DH 20

Division	NORTH PACIFIC
Installation	ALASKA
Sheet	1 of 8 sheets
Project	SNETTISHAM - MID PENSTOCK DOWNHOLE
Location	N 95,494 E 92,617
Drilling agency	CORPS OF ENGINEERS
Hole no.	DH 20
Name of driller	VERMULLEN
Direction of hole	Inclined 30, BEARING S 47° E
Thickness of overburden	3.3'
Depth drilled into rock	752.1'
Total depth of hole	755.4'
Size and type of bit	NX, BX, BXW
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	Disturbed 0, Undisturbed 0
Total number core boxes	39
Date hole	Started 16 SEPT., 1964; Completed 16 OCT., 1964
Elevation top of hole	581.1'
Total core recovery for boring	748.6' 99.53 %

Elevation	Depth	Classification of materials	% Core recov-ery	Box or sample no.	Remarks
581		MOSS, PEAT, ORGANIC SILT; SILTY GRAVEL			DUGOUT TO BEDROCK
579		DIORITE: MOD. HARD: MOD. GR.: BLACK & WHITE GNEISSIC BANDING, LT. WEA.		1	NX CORE; 100% W.R., BROWN
	10			9.9	START OF BX CORE; CORE LENGTHS TO 3.3'; 100% W.R., BROWN GRAY
	20	QTZ SEAMS COMMON		2	
				28.0	
554	30	CL. CORKSCREW FRACTURING			
550				3	CORE LENGTHS TO 5.9'
	40			44.1	
	50		100	4	
	60	CL. FRACTURING		62.1	CORE LENGTHS TO [illegible].0'; 100% W.R., GRAY
		DIORITE AND QTZ. DIORITE HARD; MED. GR.; WHITE & BLACK BANDING; FRESH.			
	70			5	
515		FRACTURED			CORE LENGTHS TO 1.0'
511	80	QTZ SEAM		80.4	CORE LENGTHS TO 37'
	90			6	95% W.R., GRAY; CORE LENGTHS TO 6.0'
495	100			98.8	

DRILLING LOG — Hole No. DH 20

Division	NORTH PACIFIC
Installation	ALASKA
Sheet	5 of 8 sheets
Project	SNETTISHAM - MID PENSTOCK - DOWN HOLE
Location	95,494 E 92,617
Drilling agency	CORPS OF ENGINEERS
Hole no.	DH 20
Name of driller	VERMULLEN
Direction of hole	Inclined 30, BEARING S 47° E
Thickness of overburden	3.3'
Depth drilled into rock	752.1'
Total depth of hole	755.4'
Size and type of bit	NX, BX, BXW
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	Disturbed 0, Undisturbed 0
Total number core boxes	39
Date hole	Started 16 SEPT. 1964; Completed 16 OCT., 1964
Elevation top of hole	581.1'
Total core recovery for boring	748.6' 99.53 %

Depth	Classification of materials	% Core recov-ery	Box or sample no.	Remarks
	DIORITE AND QTZ DIORITE: HARD TO MOD. HARD; FINE TO CSE. GR.; COLOR BANDED; QTZ AND MAFIC SEAMS COMMON.			CORE LENGTHS TO 9.0'; 90% W.R., BROWN GRAY
410			410.4	CORE LENGTHS TO 1.5'
				CORE LENGTHS TO 6.9'
420		100	24	60% W.R., GRAY
430	FRACTURED			CORE LENGTHS TO 0.5'; 70% W.R., BROWN GRAY; CORE LENGTHS TO 10.0'
			432.3	
		99	25	
	FRACTURED, CORE LOSS ON HEAVILY GROUND CORE BREAKS	66	454.7	CORE LENGTHS TO 0.6'; WIRELINE INNER CORE BARREL DID NOT ENGAGE, BARREL OVERRODE CORE CAUSING LOSS BY GRINDING & WASHING.
			26	CORE LENGTHS TO 2.6'
				CORE LENGTHS TO 9.6'
		100	480.6	
			27	
		98		

NOTE:
SEE LOG RECORDS NUMBER 1 FOR NOTES AND LEGEND

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORD NO. 5

DESIGNED:	Wm. B. Trenthwin
DRAWN:	Wm. B. Trenthwin
CHECKED:	W. G. Binkley
PREPARED:	
SUPERVISED:	M. A. Dixon, CHIEF GEOLOGY SECTION
SUBMITTED:	Edward B. Jones, CHIEF FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED:	Harvey Geng, CHIEF ENGINEERING DIVISION
APPROVED:	Clar. F. Farley, COLONEL, CE, DISTRICT ENGINEER
SCALE	DATE 20 Oct 65
FILE NUMBER	
SHEET	OF

CORPS OF ENGINEERS

DRILLING LOG — Hole No. DH 20 — Sheet 6 of 8 sheets

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - MID PENSTOCK - DOWN HOLE
Location	N 95,494 E 92,617
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 20
Name of driller	VERMULLEN
Direction of hole	Inclined 30, BEARING S 47° E
Thickness of overburden	3.3'
Depth drilled into rock	752.1'
Total depth of hole	756.4'
Size and type of bit	NX, BX, BXW
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	0 / 0
Total number core boxes	39
Date hole	16 SEPT., 1964 – 16 OCT., 1964
Elevation top of hole	581.1'
Total core recovery for boring	748.6' 99.53%

Elevation	Depth	Classification of materials	% Core recov.	Box or sample no.	Remarks
149		DIORITE AND QTZ DIORITE (AS BEFORE)	98	502.4	70% W.R., BROWN GRAY CORE LENGTHS TO 10.1'
	510			28	
	520			525.0	
	530			29	
	540		100	547.5	
	550	QTZ			
	560			30	
	570			569.9	
	580			31	
	590			592.5	
63	600			32	

DRILLING LOG — Hole No. DH 20 — Sheet 7 of 8 sheets

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - MID PENSTOCK - DOWN HOLE
Location	N 95,494 E 92,617
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 20
Name of driller	VERMULLEN
Direction of hole	Inclined 30, BEARING S 47° E
Thickness of overburden	3.3'
Depth drilled into rock	752.1'
Total depth of hole	756.4'
Size and type of bit	NX, BX, BXW
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	0 / 0
Total number core boxes	39
Date hole	16 SEPT., 1964 – 16 OCT., 1964
Elevation top of hole	581.1'
Total core recovery for boring	748.6' 99.53%

Elevation	Depth	Classification of materials	% Core recov.	Box or sample no.	Remarks
63		DIORITE AND QTZ DIORITE (AS BEFORE) QTZ SEAMS COMMON; QTZ SEAMS		32	100% W.R., BROWN GRAY CORE LENGTHS TO 10.0'
	510			614.8	
	520	QTZ	100	33	
	530			537.0	CORE LENGTHS TO 1.1' 100% W.R., MILKY WHITE CORE LENGTHS TO 6.4' CORE LENGTHS TO 4.3'
23	540	LONGITUDINAL JOINTS		34	
18	550				100% W.R., BROWN GRAY
	560	ZONE OF QTZ SEAMS	99	559.1	CORE LENGTHS TO 2.1' 100% W.R., MILKY BROWN CORE LENGTHS TO 7.7'
0	570			35	100% W.R., BROWN GRAY ← M.S.L.
	580	QTZ	100	581.4	
	690			36	CORE LENGTHS TO 1.0'
-24	700	QTZ			80% W.R., MILKY WHITE

DRILLING LOG — Hole No. DH 20 — Sheet 8 of 8 sheets

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - MID PENSTOCK - DOWN HOLE
Location	N 95,494 E 92,617
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 20
Name of driller	VERMULLEN
Direction of hole	Inclined 30, BEARING S 47° E
Thickness of overburden	3.3'
Depth drilled into rock	752.1'
Total depth of hole	756.4'
Size and type of bit	NX, BX, BXW
Manufacturer's designation of drill	JOY 12 B 400
Total no. of overburden samples taken	0 / 0
Total number core boxes	39
Date hole	16 SEPT., 1964 – 16 OCT., 1964
Elevation top of hole	581.1'
Total core recovery for boring	748.6' 99.53%

Elevation	Depth	Classification of materials	% Core recov.	Box or sample no.	Remarks
-24		DIORITE AND QTZ DIORITE (AS BEFORE) FRACTURES; OCCAS. QTZ SEAMS		36 / 703.8	88% W.R., WHITE, BROWN AND GRAY CORE LENGTHS TO 6.6'
	710			37	
	720		100	726.1	
	730			38	CORE LENGTHS TO 1.0' CORE LENGTHS TO 3.5'
	740				
	750		99	749.6 / 39	
-73	756.4				

BOTTOM OF HOLE EL.	-71.0'
DEPTH OF HOLE	756.4'
VERTICAL DEPTH	654.2'
HORIZONTAL DISTANCE	377.7'
THICKNESS OF O.B.	3.3'
ROCK CORED	752.1'
CORE RECOVERED	748.6'
% CORE RECOVERY	99.5

DRILLING LOG — Hole No. DH 21 — Sheet 3 of 5 sheets

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - POWERHOUSE - PENSTOCK
Location	N 94,833 E 93,075
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 21
Name of driller	LAWRENCE LARSON
Direction of hole	Inclined 75, BEARING N 39° W
Thickness of overburden	0.0'
Depth drilled into rock	505.6'
Total depth of hole	505.6'
Size and type of bit	NX
Manufacturer's designation of drill	SULLIVAN 22 HD
Total no. of overburden samples taken	0 / 0
Total number core boxes	35
Elevation ground water	FLOWING
Date hole	26 SEPT., 1964 – 16 OCT., 1964
Elevation top of hole	67.4'
Total core recovery for boring	505.6' 100%

Elevation	Depth	Classification of materials	% Core recov.	Box or sample no.	Remarks
16		DIORITE AND QTZ DIORITE (AS BEFORE) OCCAS. QTZ SEAMS		14 / 203.8	CORE LENGTHS TO 4.4' 100% GRAY GREEN W.R.
13	210	FRACTURES		15	CORE LENGTHS TO 0.7'
11				218.6	CORE LENGTHS TO 5.1'
	220			16	
	230			232.9	CORE LENGTHS TO 6.8'
	240		100	17 / 247.8	
3	250	FRACTURED			CORE LENGTHS TO 2.8'
+1		HORNBLENDITE, MOD. SOFT; CSE. GR.; GREEN BLACK		18	CORE LENGTHS TO 1.1'
-1	260	FRACTURED		262.4	← M.S.L. CORE LENGTHS TO 6.8'
	270			19 / 277.2	
	280				CORE LENGTHS TO 10.1'
	290			20 / 291.7	
-10	300	FRACTURED, LT. WEA.		21	

DRILLING LOG — Hole No. DH 21 — Sheet 4 of 5 sheets

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - POWERHOUSE - PENSTOCK
Location	N 94,833 E 93,075
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 21
Name of driller	LAWRENCE LARSON
Direction of hole	Inclined 75, BEARING N 39° W
Thickness of overburden	0.0'
Depth drilled into rock	505.6'
Total depth of hole	505.6'
Size and type of bit	NX
Manufacturer's designation of drill	SULLIVAN 22 HD
Total no. of overburden samples taken	0 / 0
Total number core boxes	35
Elevation ground water	MINUS 15'
Date hole	16 SEPT., 1964 – 16 OCT., 1964
Elevation top of hole	67.4'
Total core recovery for boring	505.6' 100%

Elevation	Depth	Classification of materials	% Core recov.	Box or sample no.	Remarks
-10		DIORITE AND QTZ DIORITE (AS BEFORE) FRACTURED, STRIATED SLICKS		21 / 306.9	100% W.R., GRAY CORE LENGTHS TO 1.5'
-13	310			22	CORE LENGTHS TO 6.8'
	320			321.7	
	330			23 / 336.4	
	340			24	CORE LENGTHS TO 1.7'
	350		100	351.0	
-24 / -25		FAULT ZONE; CL. FRAC., MOD SOFT; GREEN, GRAY, & BROWN SLICKS AND GOUGE.		25	CORE LENGTHS TO 0.8' CORE LENGTHS TO 4.7'
	360			367.2	
	370			26	CORE LENGTHS TO 10.1'
	380			380.8	
	390			27 / 395.7	
-35	400			28	

DRILLING LOG — Hole No. DH 21 — Sheet 5 of 6 sheets

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - POWERHOUSE - PENSTOCK
Location	N 94,833 E 93,075
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 21
Name of driller	LAWRENCE LARSON
Direction of hole	Inclined 75, BEARING N 39° W
Thickness of overburden	0.0'
Depth drilled into rock	508.6'
Total depth of hole	505.6'
Size and type of bit	NX
Manufacturer's designation of drill	SULLIVAN 22 HD
Total no. of overburden samples taken	0 / 0
Total number core boxes	35
Elevation ground water	MINUS 15'
Date hole	26 SEPT., 1964 – 16 OCT., 1964
Elevation top of hole	67.4'
Total core recovery for boring	505.6' 100%

Elevation	Depth	Classification of materials	% Core recov.	Box or sample no.	Remarks
-35		DIORITE AND QTZ DIORITE (AS BEFORE) OCCAS. QTZ SEAMS		28	100% W.R., GRAY CORE LENGTHS TO 10.0'
	410			410.4	
	420			29 / 425.6	
	430			30	
	440			440.0	
	450		100	31 / 454.8	CORE LENGTHS TO 1.8'
-50		QTZ SEAMS COMMON			
	460			32	CORE LENGTHS TO 8.6'
	470			469.6	CORE LENGTHS TO 1.5'
-56	480			33 / 484.5	
	490			34	CORE LENGTHS TO 4.0'
-61 / -62	500			499.2	

DRILLING LOG — Hole No. DH 21 (Sheet 1 of 6 sheets)

- Division: NORTH PACIFIC
- Installation: ALASKA
- Project: SNETTISHAM POWERHOUSE PENSTOCK
- Location: N 94,833 E 93,075
- Drilling agency: CORPS OF ENGINEERS
- Hole No.: DH 21
- Name of driller: LAWRENCE LARSON
- Direction of hole: Inclined 75 BEARING N 39° W
- Thickness of overburden: 0.0'
- Depth drilled into rock: 506.6'
- Total depth of hole: 506.6'
- Size and type of bit: NX
- Manufacturer's designation of drill: SULLIVAN 22 HD
- Total no. of overburden samples taken: 0 / 0
- Total number core boxes: 35
- Elevation ground water: FLOWING HOLE
- Date hole: 26 SEPT., 1964 – 16 OCT., 1964
- Elevation top of hole: 67.4'
- Total core recovery for boring: 506.6' 100%

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
67	0	DIORITE & QTZ. DIORITE. HARD, MED. TO CSE GR. WHITE & BLACK GNEISSIC BANDING LT. WEA., QTZ SEAMS COMMON			CORE LENGTHS TO 2.1' 100% W.R., GRAY
	10			1	CORE LENGTHS TO 0.4' CORE LENGTHS TO 3.8'
	14.6				
63	20	FRACTURE ZONES		2	CORE LENGTHS TO 0.6' CORE LENGTHS TO 3.8'
	28.9			3	
	43.2				CORE LENGTHS TO 5.1'
	50	FRACTURES	100	4	CORE LENGTHS TO 1.0' CORE LENGTHS TO 4.5'
	57.9				
50		QTZ.		5	
49	70	CL. FRAC., SLICKS			CORE LENGTHS TO 0.6'
	72.0			6	CORE LENGTHS TO 5.6'
	85.9			7	
42	100				

DRILLING LOG — Hole No. DH 21 (Sheet 2 of 6 sheets)

- Division: NORTH PACIFIC
- Installation: ALASKA
- Project: SNETTISHAM POWERHOUSE PENSTOCK
- Location: N 94,833 E 93,075
- Drilling agency: CORPS OF ENGINEERS
- Hole No.: DH 21
- Name of driller: LAWRENCE LARSON
- Direction of hole: Inclined 75 BEARING N 39° W
- Thickness of overburden: 0.0'
- Depth drilled into rock: 506.6'
- Total depth of hole: 506.6'
- Size and type of bit: NX
- Manufacturer's designation of drill: SULLIVAN 22 HD
- Total no. of overburden samples taken: 0 / 0
- Total number core boxes: 35
- Elevation ground water: FLOWING
- Date hole: 26 SEPT., 1964 – 16 OCT., 1964
- Elevation top of hole: 67.4'
- Total core recovery for boring: 506.6' 100%

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
42	100	DIORITE AND QUARTZ DIORITE (AS BEFORE) QTZ SEAMS COMMON			
	101.3				CORE LENGTHS TO 5.6' 100% W.R., GRAY
	110			8	
	116.2			9	
	130.6			10	CORE LENGTHS TO 7.8'
	145.5		100		CORE LENGTHS TO 2.9'
28	150	LT. WEA., RUST STAINED FRA.		11	
	159.9				CORE LENGTHS TO 10.1'
				12	
	174.3				100% W.R., GRAY GREEN
	180	CL. FRACTURED		13	CORE LENGTHS TO 0.8'
	189.2				CORE LENGTHS TO 1.3'
18	190	CL. FRACTURED		14	
16	200				

DRILLING LOG — Hole No. DH 21 (Sheet 6 of 6 sheets)

- Division: NORTH PACIFIC
- Installation: ALASKA
- Project: SNETTISHAM - POWERHOUSE - PENSTOCK
- Location: N 94,8333 E 93,075
- Drilling agency: CORPS OF ENGINEERS
- Hole No.: DH 21
- Name of driller: LAWRENCE LARSON
- Direction of hole: Inclined 75 BEARING N 39° W
- Thickness of overburden: 0.0'
- Depth drilled into rock: 506.6'
- Total depth of hole: 506.6'
- Size and type of bit: NX
- Manufacturer's designation of drill: SULLIVAN 22 HD
- Total no. of overburden samples taken: 0 / 0
- Total number core boxes: 35
- Elevation ground water: FLOWING HOLE
- Date hole: 26 SEPT., 1964 – 16 OCT., 1964
- Elevation top of hole: 67.4'
- Total core recovery for boring: 506.6' 100%

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
-62		DIORITE AND QTZ DIORITE (AS BEFORE)	100	35	CORE LENGTHS TO 3.3' 100% W.R., GRAY
-64	506.6				
		BOTTOM OF HOLE EL. -63.7' DEPTH OF HOLE 506.6' VERTICAL DEPTH 131.1' HORIZONTAL DEPTH 489.3' THICKNESS OF O.B. 0.0' ROCK CORED 506.6' CORE RECOVERED 506.6' % CORE RECOVERY 100			WATER FLOWING OUT OF HOLE UPON COMPLETION

NOTE:
SEE LOG RECORDS NUMBER 1 FOR NOTES AND LEGEND

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORD NO. 6

- DESIGNED: Wm. B. Trautwein
- DRAWN: Wm. B. Trautwein
- CHECKED: W. G. Binkley
- PREPARED:
- SUPERVISED: R. A. Dixon, CHIEF GEOLOGY SECTION
- SUBMITTED: CHIEF FOUNDATIONS & MATERIALS BRANCH
- RECOMMENDED: Warren George, CHIEF ENGINEERING DIVISION
- APPROVED: Clay T. Farley, COLONEL, CE, DISTRICT ENGINEER
- SCALE
- DATE 20 Oct 65
- FILE NUMBER
- SHEET OF

CORPS OF ENGINEERS

DRILLING LOG — NORTH PACIFIC — ALASKA — Hole No. DH 22 — Sheet 1 of 6 sheets

SNETTISHAM - GLACIER CREEK FAULT | NX
N 97,100 E 93,360 | MSL
CORPS OF ENGINEERS | JOY 128 401
DH 22 | 0 0
DON DUPUIS, DON SCHILL | 35
0 | 26 SEP., 1964 21 OCT., 1964
3.9' | 492.9
529.8' | 524.0 98.9 %
533.7'

Elevation 493	Depth	Classification of Materials	% Core Recovery	Box or Sample No.	Remarks
		PEAT, MOSSY, BROWN			FISHTAIL ROCK BIT
489		CLAYEY SILT: ORGANIC, BLACK			THRU OVERBURDEN
		QUARTZ DIORITE: MOD HARD; LT WEA; MED GR.; BLACK & WHITE GNEISSIC BANDING.	92	3.9	CORE LENGTHS TO 1.5' 100% W.R., WHITE & BROWN
	10		100		SOFT SEAM, RAPID PENETRATION
		POSSIBLE FAULT: CL FRAC.; SOFT SEAMS, YELLOW GREEN & BROWN, MOD WEA.		1	CORE LENGTHS TO 2.8'
			90		RAN NX CASING TO 13.0'
	20			20.9	100% W.R., GREEN GRAY
		SLICKS, RUST STAINED, CLAY COATED			CORE LENGTHS TO 4.4'
	30			2	
				35.4	CORE LENGTHS TO 3.0'
	40	CLAY COATING ON JOINT; QTZ. SEAM			100% W.R., WHITE & GRAY
		SLICKS, 1/8" CLAY 1.0' MOD WEA, RUST STAINED ZONE	100	3	
	50			50.2	CORE LENGTHS TO 8.2'
		1" WEA., BROWN SEAM, DIP 45°		4	CORE LENGTHS TO 1.4'
	60	RUST STAINED SLICKS			
				65.0	CORE LENGTHS TO 8.2'
	70			5	
	80			79.6	CORE LENGTHS TO 2.0'
	90		10	6	CORE LENGTHS TO 0.5'
402		CL. FRAC., WEA., RUST STAINED, CLAY SEAMS, HI. CORE LOSS			
398		FRAC.		95.4	
393	100		100	7	CORE LENGTHS TO 1.2'

DRILLING LOG — NORTH PACIFIC — ALASKA — Hole No. DH 22 — Sheet 2 of 6 sheets

SNETTISHAM - GLACIER CREEK FAULT | NX
N 97,100 E 93,360 | MSL
CORPS OF ENGINEERS | JOY 128 401
DH 22 | 0 0
DON DUPUIS, DON SCHILL | 35
0 | 26 SEP., 1964 21 OCT., 1964
3.9' | 492.9
529.8' | 524.0 98.9 %
533.7'

Elevation 393	Depth	Classification of Materials	% Core Recovery	Box or Sample No.	Remarks
		DIORITE & QTZ. DIORITE: HARD; MED. TO FINE GR., BLACK & WHITE GNEISSIC BANDING.		7	CORE LENGTH TO 7.4' 100% W.R., WHITE & GRAY
			100		
	110			110.1	
378		STRIATED SLICKS & SOFT SEAMS	80	8	CORE LENGTHS TO 0.6' 100% W.R., BROWN, YELLOW
375		WEA., CL. FRAC.			
	120				CORE LENGTHS TO 8.2' 100% W.R., GRAY & WHITE
				125.4	
	130			9	
	140	QTZ.		140.1	
				10	
	150		100	154.9	
	160			11	CORE LENGTHS TO 3.7'
	170			169.6	
	180			12	
				184.6	CORE LENGTHS TO 10.2'
	190			13	
293	200			199.3	

DRILLING LOG — NORTH PACIFIC — ALASKA — Hole No. DH 22 — Sheet 3 of 6 sheets

SNETTISHAM - GLACIER CREEK FAULT | NX
N 97,100 E 93,360 | MSL
CORPS OF ENGINEERS | JOY 128
DH 22 | 0 0
DON DUPUIS | 35
0 | 26 SEP., 1964 21 OCT., 1964
3.9' | 492.9
529.8' | 524.0 98.9 %
533.7'

Elevation 293	Depth	Classification of Materials	% Core Recovery	Box or Sample No.	Remarks
		DIORITE & QTZ. DIORITE: HARD; FINE TO MEDIUM GRAINED; WHITE AND BLACK; MASSIVE, FRESH; QUARTZ DOMINANT.			CORE LENGTHS TO 10.0' 100% WHITE TO GRAY W.R.
				14	
	210			214.3	
	220			15	
				228.9	
	230			16	
	240			243.6	
			100		
	250			17	
		QUARTZ-FELDSPAR-GARNET SEAMS COMMON			100% W.R., WHITE VERY SLOW DRILLING
				258.6	ROCK VERY HARD
231	260	QUARTZ-FELDSPAR DIKE: COMMON GARNET & HORNBLENDE; HARD; CSE TO MED. GR.; VARICOLORED; CHEM. ALT.		18	
223	270	SLICKS, SOFT, WHITE CLAY COATINGS			CORE LENGTHS TO 0.8'
				274.1	CORE LENGTHS TO 2.4'
	280			19	CORE LENGTHS TO 9.2'
207		SLICKS, SOFT WHITE & BLUE GRAY COATINGS		288.8	
	290			20	
193	300				

DRILLING LOG — NORTH PACIFIC — ALASKA — Hole No. DH 22 — Sheet 6 of 6 sheets

SNETTISHAM - GLACIER CREEK FAULT | NX
N 97,100 E 93,360 | MSL
CORPS OF ENGINEERS | JOY 128 401
DH 22 | 0 0
DON SCHILL | 35
0 | 26 SEP., 1964 21 OCT., 1964
3.9' | 492.9
529.8' | 524.0 98.9 %
533.7'

Elevation -07	Depth	Classification of Materials	% Core Recovery	Box or Sample No.	Remarks
		QUARTZ DIORITE: HARD; FINE GRAINED; WHITE, BLACK, PINK; MASSIVE, FRESH; SOME GARNET			CORE LENGTHS TO 10.0'
				34	100% W.R., GRAY TO WHITE
		QTZ. SEAM			
	510			510.4	
			100	35	
-26	520	FRACTURED			CORE LENGTHS TO 1.2'
-32					CORE LENGTHS TO 5.4'
	530				
-41	533.7	CL. FRAC., SLICKS			

BOTTOM OF HOLE ELEV.	-40.8
DEPTH OF HOLE	533.7'
THICKNESS OF O.B.	3.9'
ROCK CORED	529.8'
CORE RECOVERED	524.0'
% CORE RECOVERY	98.9

DRILLING LOG — NORTH PACIFIC — ALASKA — Hole No. DH 23 — Sheet 1 of 5 sheets

SNETTISHAM - MID PENSTOCK | NX BXW
N 95,493 E 92,617 | MSL
CORPS OF ENGINEERS | JOY 128 400
DH 23 | 0 0
JAMES VERMULLEN | 24
60 BEARING N 70° W | FLOWING 60 GPM
23.4' | 20 OCT., 1964 4 NOV., 1964
516.3' | 581.9'
539.7' | 508.3' 98.45 %

Elevation 582	Depth	Classification of Materials	% Core Recovery	Box or Sample No.	Remarks
		SILT: PEATY, ORGANIC, BLACK			WASHED AND CAPPED, NX CASING TO 23.4'
	10				
	20				WIRELINE CORE BARREL
570		DIORITE AND QTZ. DIORITE: HARD; FINE TO MED.GR.; WHITE & BLACK GNEISSIC BANDING; FRACTURED		1	CORE LENGTHS TO 1.8' 100% W.R., BROWN, WHITE & GRAY
	30			29.8	
	40			2	
559		BASALT: SOFT, BROWN, ALT.			
	50			50.4	
		BASALT: MOD HARD; DENSE.			CORE LENGTHS TO 5.7'
	60	BASALT: HARD TO SOFT; DENSE; FINE GR.; BLACK, GRAY, GREEN	100	3	100% W.R., BROWN GRAY
	70			72.1	
541	80	BASALT: MOD HARD; DENSE; GREEN BLACK, APHANITIC		4	
537	90	CL. FRACTURED			CORE LENGTHS TO 0.8'
533				94.4	
532	100			5	CORE LENGTHS TO 2.1'

DRILLING LOG — NORTH PACIFIC — ALASKA — Hole No. DH 23 — Sheet 2 of 5 sheets

SNETTISHAM - MID PENSTOCK | BXW
N 95,493 E 92,617 | MSL
CORPS OF ENGINEERS | JOY 12 B 400
DH 23 | 0 0
VERMULLEN - HELPER KLICKER | 24
60 BEARING N 70° W | FLOWING 60 GPM
23.4' | 20 OCT., 1964 4 NOV., 1964
516.3' | 581.9'
539.7' | 508.3 98.45 %

Elevation 532	Depth	Classification of Materials	% Core Recovery	Box or Sample No.	Remarks
531		DIORITE AND QTZ. DIORITE (AS BEFORE)			CORE LENGTHS TO 2.8' 100% W.R., MILKY WHITE & BROWN
		BASALT: HARD, DENSE; APHANITIC TO MED.GR.; GRAY GREEN; PORPHYRITIC		5	
	110	CL. FRAC.			
		BASALT			
				116.3	
		FRACTURED			
	120	BASALT, (AS ABOVE)			
521					100% W.R., MILKY WHITE & GRAY
				6	
517	130				CORE LENGTHS TO 3.5'
				138.2	
	140				
510		BASALT: MOD HARD; BROWN			CORE LENGTHS TO 2.1' 100% W.R., WHITE & BROWN
508		FRACTURED	100	7	CORE LENGTHS TO 8.2'
	150				
	160			160.3	
	170			8	
	180				
491		BASALT: HARD, APHANITIC, VESICULAR, GREEN GRAY		182.7	
	190			9	
		(AS ABOVE)			
482	200				

Hole No. DH 22

DRILLING LOG	DIVISION: NORTH PACIFIC	INSTALLATION: ALASKA	SHEET 4 OF 6 SHEETS
PROJECT: SNETTISHAM - GLACIER CREEK FAULT		SIZE AND TYPE OF BIT: NX	
LOCATION: N 97,100 E 93,360		DATUM FOR ELEVATION SHOWN: MSL	
DRILLING AGENCY: CORPS OF ENGINEERS		MANUFACTURER'S DESIGNATION OF DRILL: JOY 12B 401	
HOLE NO.: DH 22		TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 0 / 0	
NAME OF DRILLER: DON DUPUIS		TOTAL NUMBER CORE BOXES: 35	
DIRECTION OF HOLE: VERTICAL, 0 DEG. FROM VERT.		DATE HOLE: STARTED 26 SEP. 1964; COMPLETED 21 OCT. 1964	
THICKNESS OF OVERBURDEN: 3.9'		ELEVATION TOP OF HOLE: 492.9	
DEPTH DRILLED INTO ROCK: 529.8'		TOTAL CORE RECOVERY FOR BORING: 524.0 / 98.9 %	
TOTAL DEPTH OF HOLE: 533.7'		SIGNATURE OF INSPECTOR	

Elevation 193

Elevation	Depth	Classification of Materials	% Core Recov.	Box or Sample No.	Remarks
		QTZ. FELDSPAR DIKE (AS BEFORE)		20	CORE LENGTHS TO 4.0' 100% W.R., WHITE
				303.3	
	310			21	CORE LENGTHS TO 8.3'
				318.4	
	320			22	
		SLICKS, SOFT WHITE COATINGS			CORE LENGTHS TO 1.4'
	330				CORE LENGTHS TO 8.4'
				333.0	
166		QUARTZ DIORITE: HARD, FINE TO MEDIUM GRAINED; WHITE AND BLACK; MASSIVE, FRESH			
	340			23	
			100	347.5	
	350			24	
		STRIATED SLICKS-¼" SOFT GREEN GRAY PLASTIC GOUGE			CORE LENGTHS TO 2.4'
	360			362.2	
128		QUARTZ FELDSPAR: HARD; WHITE; VARICOLORED; MED. TO CSE. GRAINED; HAIRLINE FRACTURING COMMON; FRACTURES ARE SLICKEN SIDED WITH SOFT GREENISH GRAY AND WHITE TALC COATINGS (SHEAR ZONE)			
	370			25	
				375.9	
	380			26	
105		GRANITE: HARD; MED. GR.; WHITE, GRAY & PINK			CORE LENGTHS TO 4.0'
	390			391.4	
				27	
93	400				

Hole No. DH 22

DRILLING LOG	DIVISION: NORTH PACIFIC	INSTALLATION: ALASKA	SHEET 5 OF 6 SHEETS
PROJECT: SNETTISHAM - GLACIER CREEK FAULT		SIZE AND TYPE OF BIT: NX	
LOCATION: N 97,100 E 93,360		DATUM FOR ELEVATION SHOWN: MSL	
DRILLING AGENCY: CORPS OF ENGINEERS		MANUFACTURER'S DESIGNATION OF DRILL: JOY 12B 401	
HOLE NO.: DH 22		TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 0 / 0	
NAME OF DRILLER: DON DUPUIS, DON SCHILL		TOTAL NUMBER CORE BOXES: 35	
DIRECTION OF HOLE: VERTICAL, 0 DEG. FROM VERT.		DATE HOLE: STARTED 26 SEP. 1964; COMPLETED 21 OCT. 1964	
THICKNESS OF OVERBURDEN: 3.9'		ELEVATION TOP OF HOLE: 492.9	
DEPTH DRILLED INTO ROCK: 529.8		TOTAL CORE RECOVERY FOR BORING: 524.0 / 98.9%	
TOTAL DEPTH OF HOLE: 533.7'		SIGNATURE OF INSPECTOR	

Elevation 93

Elevation	Depth	Classification of Materials	% Core Recov.	Box or Sample No.	Remarks
		GRANITE: HARD, PINK, WHITE, GRAY		27	CORE LENGTHS TO 1.9' 100% W.R., WHITE, GRAY, GREEN, BLACK, & PINK
90		HORN BLENDITE: MOD. HARD; GRAY, WHITE, PINK, GREEN, BLACK; CLOSE HAIRLINE FRACTURING		405.2	
84	410	QUARTZ FELDSPAR: HARD; GRAY, WHITE, PINK, GREEN BLACK; BRECCIA, SLICKENSIDES, GOUGE, SHEAR ZONE, SLICKENSIDES ON FRACTURES		28	CORE LENGTHS TO 0.4'
	420	VERY CLOSE FRACTURING		420.7	
		SOFT, WHITE & GRAY, TALC-LIKE COATINGS ALONG CLOSE FRACTURINGS		29	CORE LENGTHS TO 1.4' 100% W.R., MILK, WHITE
	430			435.6	
		VERY CLOSE FRACTURING			
	440			30	
		(GLACIER CREEK SHEAR ZONE)	100		SAMPLE NO. 1 447.9-448.8
	450			451.3	CORE LENGTHS TO 0.4'
		VERY CLOSE FRACTURING		31	CORE LENGTHS TO 1.7'
	460			465.1	
					100% W.R., GREEN GRAY
24	470	CLAY SEAMS: SOFT GREEN-GRAY		32	
		GLACIER CREEK FAULT			SAMPLE NO. 2 475.5 TO 476.6
		FAULT GOUGE: SOFT; GREEN GRAY; BRECCIATED & RE-CEMENTED			SAMPLE NO. 3 476.6 - 478.8
	480	GREEN CLAY SEAM		479.6	
9		QUARTZ DIORITE: HARD; FINE GRAINED; WHITE, BLACK, PINK, GRAY	88	33	CORE LENGTHS TO 1.8'
	490	ZONE OF SLICKENSIDED FRACTURING			M.S.L.
			100	495.2	
				34	CORE LENGTHS TO 3.6' 100% W.R., WHITE
-07	500				

Hole No. DH 23

DRILLING LOG	DIVISION: NORTH PACIFIC	INSTALLATION: ALASKA	SHEET 3 OF 6 SHEETS
PROJECT: SNETTISHAM - MID PENSTOCK		SIZE AND TYPE OF BIT: BXM	
LOCATION: N 95,493 E 92,617		DATUM FOR ELEVATION SHOWN: MSL	
DRILLING AGENCY: CORPS OF ENGINEERS		MANUFACTURER'S DESIGNATION OF DRILL: JOY 12 B 400	
HOLE NO.: DH 23		TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 0 / 0	
NAME OF DRILLER: VERMULLEN		TOTAL NUMBER CORE BOXES: 24	
DIRECTION OF HOLE: INCLINED 60 DEG. FROM VERT., BEARING N 70° W		ELEVATION GROUND WATER: FLOWING 60 GPM	
		DATE HOLE: STARTED 20 OCT. 1964; COMPLETED 4 NOV. 1964	
THICKNESS OF OVERBURDEN: 23.4'		ELEVATION TOP OF HOLE: 581.9'	
DEPTH DRILLED INTO ROCK: 515.3'		TOTAL CORE RECOVERY FOR BORING: 508.3 / 98.45%	
TOTAL DEPTH OF HOLE: 539.7'		SIGNATURE OF INSPECTOR	

Elevation 482

Elevation	Depth	Classification of Materials	% Core Recov.	Box or Sample No.	Remarks
		DIORITE AND QTZ DIORITE: HARD; FINE TO MED. GR., WHITE & BLACK BANDED; COMMON QTZ SEAMS		9	CORE LENGTHS TO 4.3' 100% W.R., BROWN GRAY
				205.0	
	210		100		CORE LENGTHS TO 1.3'
				10	CORE LENGTHS TO 2.7'
	220				CORE LENGTHS TO 0.6'
				225.8	100% W.R. MILKY WHITE
	230		99		CORE LENGTHS TO 3.0'
				11	CORE LENGTHS TO 0.4'
	240				CORE LENGTHS TO 6.2'
	250			249.4	
451	260	FRACTURED	100	12	CORE LENGTHS TO 6.8'
448	270			271.5	CORE LENGTHS TO 4.6'
	280			13	
	290				CORE LENGTHS TO 1.0'
				293.6	CORE LENGTHS TO 3.1'
432	300			14	100% W.R., WHITE TO BROWN

NOTE

SEE LOG RECORDS NUMBER 1 FOR NOTES AND LEGEND

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE ALASKA

DESIGNED: Wm. B. TRANTHAM	SNETTISHAM PROJECT, ALASKA FIRST STAGE DEVELOPMENT
DRAWN: Wm. B. TRANTHAM	
CHECKED: Bd. Lacosa	**LOG RECORD NO. 7**
PREPARED:	
SUPERVISED: M. A. Dixon, CHIEF, GEOLOGY SECTION	APPROVED: Claude Farley, COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: [signature], CHIEF, FOUNDATIONS & MATERIALS BRANCH	SCALE / DATE 20 Oct 65
RECOMMENDED: Warren George, CHIEF, ENGINEERING DIVISION	FILE NUMBER
	SHEET OF

2

CORPS OF ENGINEERS

Hole No. DH 23

DRILLING LOG	DIVISION: NORTH PACIFIC	INSTALLATION: ALASKA	SHEET 4 of 6 SHEETS
1. PROJECT: SNETTISHAM - MID PENSTOCK		10. SIZE AND TYPE OF BIT: BXW	
2. LOCATION: N 95,493 E 92,617		11. DATUM FOR ELEVATION SHOWN: MSL	
3. DRILLING AGENCY: CORPS OF ENGINEERS		12. MANUFACTURER'S DESIGNATION OF DRILL: JOY 12 B 400	
4. HOLE NO.: DH 23		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0, UNDISTURBED 0	
5. NAME OF DRILLER: JAMES VERMULLEN		14. TOTAL NUMBER CORE BOXES: 24	
6. DIRECTION OF HOLE: INCLINED 60, BEARING N 70° W		15. ELEVATION GROUND WATER: FLOWING 60 GPM	
7. THICKNESS OF OVERBURDEN: 23.4'		16. DATE HOLE: STARTED 20 OCT., 1964, COMPLETED 4 NOV., 1964	
8. DEPTH DRILLED INTO ROCK: 516.3'		17. ELEVATION TOP OF HOLE: 581.9'	
9. TOTAL DEPTH OF HOLE: 539.7'		18. TOTAL CORE RECOVERY FOR BORING: 508.3' 98.45 %	

ELEVATION 432	DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOV-ERY	BOX OR SAMPLE NO.	REMARKS
		DIORITE AND QTZ. DIORITE (AS BEFORE)		14	CORE LENGTHS TO 4.0' 200% W.R., WHITE TO BROWN, ARTESIAN WATER RETURN
	310				
		CL. FRAC.; RUST STAINED; LT. TO MOD. WEA.		316.0	
	320				CORE LENGTHS TO 0.8'
					CORE LENGTHS TO [illegible]
				15	
	330				
413				338.6	CORE LENGTHS TO 1.0'
	340	FRACTURED	100		
405	350			16	CORE LENGTHS TO 3.6'
401	360			361.2	CORE LENGTHS TO 0.5'
398		FRACTURED			CORE LENGTHS TO 4.0'
	370			17	
391	380	FRACTURED		383.4	CORE LENGTHS TO 0.8'
386	390			18	CORE LENGTHS TO 3.3'
384					CORE LENGTHS TO 0.6'
382	400	FRACTURED			

Hole No. DH 23

DRILLING LOG	DIVISION: NORTH PACIFIC	INSTALLATION: ALASKA	SHEET 5 of 6 SHEETS
1. PROJECT: SNETTISHAM - MID PENSTOCK		10. SIZE AND TYPE OF BIT: BXW	
2. LOCATION: N 95,493 E 92,617		11. DATUM FOR ELEVATION SHOWN: MSL	
3. DRILLING AGENCY: CORPS OF ENGINEERS		12. MANUFACTURER'S DESIGNATION OF DRILL: JOY 12 B 400	
4. HOLE NO.: DH 23		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 0 0	
5. NAME OF DRILLER: JAMES VERMULLEN		14. TOTAL NUMBER CORE BOXES: 24	
6. DIRECTION OF HOLE: INCLINED 60, BEARING N 70° W		15. ELEVATION GROUND WATER: FLOWING 60 GPM	
7. THICKNESS OF OVERBURDEN: 23.4'		16. DATE HOLE: 20 OCT., 1964 4 NOV., 1964	
8. DEPTH DRILLED INTO ROCK: 516.3'		17. ELEVATION TOP OF HOLE: 581.9'	
9. TOTAL DEPTH OF HOLE: 539.7'		18. TOTAL CORE RECOVERY FOR BORING: 508.9' 98.45 %	

ELEVATION 382	DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOV-ERY	BOX OR SAMPLE NO.	REMARKS
		DIORITE AND QTZ DIORITE; MOD HARD; OTHERWISE AS ABOVE		18	CORE LENGTHS TO 1.7' 200% W.R., WHITE, BROWN, AND GRAY ARTESIAN WATER CLEAR WHEN NOT DRILLING.
				405.5	
	410				
374				19	CORE LENGTHS TO 0.5'
	420	CL. FRAC.			
		CHEM. ALT. ZONE			
370				427.8	CORE LENGTHS TO 5.5' 190% WHITISH GRAY WATER RETURN
	430				
				20	CORE LENGTHS TO 9.9'
	440		100		
	450			449.9	
					CORE LENGTHS TO 5.0'
	460			21	
	470			472.1	CORE LENGTHS TO 8.8'
	480			22	
		CL. FRAC.; CHEM. ALT.			CORE LENGTHS TO 0.3'
	490				
336		LAMPROPHYRE DIKE; HARD; BROWN GRAY & GREEN			
334		RECEMENTED BRECCIA		494.2	
		CAVITY; PROBABLE OPEN JOINT OR FAULT SOLUTION CAVITY	32	23	7.0' ROD DROP
332	500				

Hole No. DH 23

DRILLING LOG	DIVISION: NORTH PACIFIC	INSTALLATION: ALASKA	SHEET 6 of 6 SHEETS
1. PROJECT: SNETTISHAM - MID PENSTOCK		10. SIZE AND TYPE OF BIT: BXW	
2. LOCATION: N 95,493 E 92,617		11. DATUM FOR ELEVATION SHOWN: MSL	
3. DRILLING AGENCY: CORPS OF ENGINEERS		12. MANUFACTURER'S DESIGNATION OF DRILL: JOY 12 B 400	
4. HOLE NO.: DH 23		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 0 0	
5. NAME OF DRILLER: JAMES VERMULLEN		14. TOTAL NUMBER CORE BOXES: 24	
6. DIRECTION OF HOLE: INCLINED 60, BEARING N 70° W		15. ELEVATION GROUND WATER: FLOWING 60 GPM	
7. THICKNESS OF OVERBURDEN: 23.4'		16. DATE HOLE: 20 OCT., 1964 4 NOV., 1964	
8. DEPTH DRILLED INTO ROCK: 516.3'		17. ELEVATION TOP OF HOLE: 581.9'	
9. TOTAL DEPTH OF HOLE: 539.7'		18. TOTAL CORE RECOVERY FOR BORING: 508.3' 98.45 %	

ELEVATION 332	DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOV-ERY	BOX OR SAMPLE NO.	REMARKS
331		CAVITY	32 / 70		7.0' ROD DROP CORE LENGTHS TO 1.0' 190% W.R., WHITE TO CLEAR
		QTZ. DIORITE; WHITE & VARICOLORED; HARD TO MOD. HARD; CHEM. ALT. WITH MANY LARGE QTZ. VEINS; CL. FRAC. WITH SOFT TALC-LIKE COATING ON SLICKED SURFACES	100	23	
	510				WATER FLOWING @ 60 GPM UPON COMPLETION OF HOLE.
			98		SHUT IN GAGE PRESSURE ON HOLE WAS 10# ±.
	520			523.5	WATER CAME UP AROUND BOTTOM OF CASING (POSSIBLY BYPASS THRU CRACKS IN ROCK) SO TRUE PRESSURE COULD NOT BE DETERMINED.
319		DIORITE AND QTZ. DIORITE; HARD; FINE TO MED. GR.; WHITE, GRAY & BLACK BANDED	86		
	530			24	
			100		
313		CL. FRAC.		539.7	
312.1	539.7				

BOTTOM OF HOLE	EL. 312.1'
DEPTH OF HOLE	539.7'
VERTICAL DEPTH	269.8'
HORIZONTAL DISTANCE	467.4'
THICKNESS OF O.B.	23.4'
ROCK CORED	516.3'
CORE RECOVERED	508.3'
% CORE RECOVERED	98.45

Hole No. DH 24

DRILLING LOG	DIVISION: NORTH PACIFIC	INSTALLATION: ALASKA	SHEET 3 of 4 SHEETS
1. PROJECT: SNETTISHAM - POWER HOUSE		10. SIZE AND TYPE OF BIT: NX	
2. LOCATION: N 94,828 E 93,081		11. DATUM FOR ELEVATION SHOWN: MSL	
3. DRILLING AGENCY: CORPS OF ENGINEERS		12. MANUFACTURER'S DESIGNATION OF DRILL: SULLIVAN 22 HD	
4. HOLE NO.: DH 24		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0, UNDISTURBED 0	
5. NAME OF DRILLER: LAWRENCE LARSON		14. TOTAL NUMBER CORE BOXES: 21	
6. DIRECTION OF HOLE: INCLINED 50, BEARING S 78° W		15. ELEVATION GROUND WATER: -12'	
7. THICKNESS OF OVERBURDEN: 5.7'		16. DATE HOLE: STARTED 21 OCT., 1964, COMPLETED 28 OCT., 1964	
8. DEPTH DRILLED INTO ROCK: 307.1'		17. ELEVATION TOP OF HOLE: 62.8'	
9. TOTAL DEPTH OF HOLE: 312.8'		18. TOTAL CORE RECOVERY FOR BORING: 307.1' 100 %	

ELEVATION -66	DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOV-ERY	BOX OR SAMPLE NO.	REMARKS
		DIORITE AND QTZ DIORITE (AS BEFORE)		14	CORE LENGTHS TO 4.4' 100% W.R., GRAY
	210			212.9	
	220			15	
				227.9	
	230				
-87		FRACTURED			
-88		SLICKS; WEATHERED		16	CORE LENGTHS TO 10.0'
	240			242.8	
	250	OCCAS. QTZ SEAMS	100	17	
				257.6	
	260			18	
	270			272.4	
	280			19	
				287.1	
	290			20	
-130	300				

Hole No. DH 24

DRILLING LOG	DIVISION: NORTH PACIFIC	INSTALLATION: ALASKA	SHEET 4 of 4 SHEETS
1. PROJECT: SNETTISHAM - POWER HOUSE		10. SIZE AND TYPE OF BIT: NX	
2. LOCATION: N 94,828 E 93,081		11. DATUM FOR ELEVATION SHOWN: MSL	
3. DRILLING AGENCY: CORPS OF ENGINEERS		12. MANUFACTURER'S DESIGNATION OF DRILL: SULLIVAN 22 HD	
4. HOLE NO.: DH 24		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 0 0	
5. NAME OF DRILLER: LAWRENCE LARSON		14. TOTAL NUMBER CORE BOXES: 21	
6. DIRECTION OF HOLE: INCLINED 50, BEARING S 78° W		15. ELEVATION GROUND WATER: -12	
7. THICKNESS OF OVERBURDEN: 5.7'		16. DATE HOLE: 21 OCT., 1964 28 OCT., 1964	
8. DEPTH DRILLED INTO ROCK: 307.1'		17. ELEVATION TOP OF HOLE: 62.8'	
9. TOTAL DEPTH OF HOLE: 312.8'		18. TOTAL CORE RECOVERY FOR BORING: 307.1' 100 %	

ELEVATION -130	DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOV-ERY	BOX OR SAMPLE NO.	REMARKS
		DIORITE AND QTZ DIORITE (AS BEFORE)	100	21	CORE LENGTHS TO 5.3' 100% W.R., GRAY
	310				
-138					

BOTTOM OF HOLE EL.	-138.2'
DEPTH OF HOLE	312.8'
VERTICAL DEPTH	201.0'
HORIZONTAL DISTANCE	239.5'
THICKNESS OF O.B.	5.7'
ROCK CORED	307.1'
CORE RECOVERED	307.1'
% CORE RECOVERED	100

Hole No. DH 25

DRILLING LOG	DIVISION: NORTH PACIFIC	INSTALLATION: ALASKA	SHEET 1 of 5 SHEETS
1. PROJECT: SNETTISHAM - MID TUNNEL		10. SIZE AND TYPE OF BIT: NX	
2. LOCATION: N 100,098 E 93,330		11. DATUM FOR ELEVATION SHOWN: MSL	
3. DRILLING AGENCY: CORPS OF ENGINEERS		12. MANUFACTURER'S DESIGNATION OF DRILL: JOY 12 B 401	
4. HOLE NO.: DH 25		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 0 0	
5. NAME OF DRILLER: WM. BURGESS, DON SCHILL		14. TOTAL NUMBER CORE BOXES: 32	
6. DIRECTION OF HOLE: INCLINED 70, BEARING N 30° W		15. ELEVATION GROUND WATER:	
7. THICKNESS OF OVERBURDEN: 2.3'		16. DATE HOLE: 23 OCT., 1964 7 NOV., 1964	
8. DEPTH DRILLED INTO ROCK: 470.4'		17. ELEVATION TOP OF HOLE: 1656'	
9. TOTAL DEPTH OF HOLE: 472.7'		18. TOTAL CORE RECOVERY FOR BORING: 470.4' 100 %	

ELEVATION 1656.0	DEPTH	CLASSIFICATION OF MATERIALS	% CORE RECOV-ERY	BOX OR SAMPLE NO.	REMARKS
		SILT, ORGANIC, BROWN-BLACK		2.3	
1654.3		BASALT-MOD. HARD, DENSE, APHANITIC, BROWN, GREEN, GRAY, CL. FRAC., MOD. WEA.,			CORE LENGTHS TO 0.6' 100% W.R., GREEN GRAY
1650.3	10	QUARTZ DIORITE - HARD, FINE TO MED. GR., WHITE & BLACK, CL. FRAC., MOD. WEA.,		1	CORE LENGTHS TO 0.9' 100% W.R., GREEN
1649.3		BASALT (AS ABOVE) SLIGHTLY VESICULAR, CL. FRAC.,		18.8	
	20				CORE LENGTHS TO 1.8' 100% W.R., GRAY CORE LENGTHS TO 0.6'
1646.5				2	
	30				CORE LENGTHS TO 1.0' 100% W.R., WHITE W.T. @ EL.
		BASALT SEAMS		33.9	CORE LENGTHS TO 3.0'
	40	BASALT (AS ABOVE)		3	CORE LENGTHS TO 0.7' 100% W.R., GREEN,
					100% W.R., GREEN, WHITE, BROWN & GRAY
		HI. WEA., VERY CL. FRAC.,			CORE LENGTHS TO 1.4'
	50		100	50.5	100% W.R., GRAY
1637.9		QTZ. DIO. WIDELY SPACED FRACTURING, LT. WEA.,			CORE LENGTHS TO 7.2'
				4	
	60				
				64.7	
	70			5	
	80			79.4	CORE LENGTHS TO 2.8'
				6	
1624.0	90	BASALT			CORE LENGTHS TO 0.8'
1623.0				94.7	CORE LENGTHS TO 1.7'
				7	
1620.8	100				

U. S. ARMY

DRILLING LOG — Hole No. DH 24 (Sheet 1 of 4 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - POWER HOUSE
Location	N 94,828 E 93,081
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 24
Name of driller	LAWRENCE LARSON
Direction of hole	Inclined 50 BEARING S 78° W
Thickness of overburden	5.7'
Depth drilled into rock	307.1'
Total depth of hole	312.8'
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	SULLIVAN 22 HD
Total no. of overburden samples taken	Disturbed 0 / Undisturbed 0
Total number core boxes	21
Elevation ground water	12'
Date hole	Started 21 OCT., 1964 / Completed 27 OCT., 1964
Elevation top of hole	62.8'
Total core recovery for boring	307.1' 100 %

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
63		SILT: ORGANIC, BLACK, OCCAS. COBBLES			
59	10	DIORITE AND QTZ. DIORITE: HARD, FINE TO MED. GR., WHITE & BLACK GNEISSIC BANDING, OCCAS. QTZ. SEAMS		1	CORE LENGTHS TO 1.0' 100% W.R., GRAY
		FRACTURED			CORE LENGTHS TO 6.8'
	20			20.6	
	30			2	CORE LENGTHS TO 3.9'
				35.9	
	40			3	
	50		100	50.3	
	60			4	CORE LENGTHS TO 9.3'
				65.4	
	70				
15		SLICKS, STRIATED, WEATHERED		5	
	80			80.1	
	90			6	CORE LENGTHS TO 3.6'
				94.8	
0 / -1.5	100			7	← M.S.L.

DRILLING LOG — Hole No. DH 24 (Sheet 2 of 4 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - POWER HOUSE
Location	N 94,828 E 93,081
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 24
Name of driller	LAWRENCE LARSON
Direction of hole	Inclined 50 BEARING S 78° W
Thickness of overburden	5.7'
Depth drilled into rock	307.1'
Total depth of hole	312.8'
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	SULLIVAN 22 HD
Total no. of overburden samples taken	0 / 0
Total number core boxes	21
Elevation ground water	12'
Date hole	Started 21 OCT., 1964 / Completed 28 OCT., 1964
Elevation top of hole	62.8'
Total core recovery for boring	307.1' 100 %

Elevation	Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
-1.5		DIORITE AND QTZ DIORITE (AS BEFORE)		7	CORE LENGTHS TO 10.0' 100% W.R., GRAY
	110			109.7	
	120			8	
				124.5	
	130			9	CORE LENGTHS TO 3.5'
	140			139.2	
		CHEM. ALT. ZONE, SLICKS	100	10	CORE LENGTHS TO 8.4'
	150			153.7	CORE LENGTHS TO 4.4'
	160			11	
				158.4	CORE LENGTHS TO 10.0'
	170			12	
	180			183.5	
	190			13	
66	200			198.2 / 14	

DRILLING LOG — Hole No. DH 25 (Sheet 2 of 5 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - MID TUNNEL
Location	100,098 E 93,330
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 25
Name of driller	DON SCHILL
Direction of hole	Inclined 20 BEARING N 36° W
Thickness of overburden	2.3'
Depth drilled into rock	470.4'
Total depth of hole	472.7'
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0 / 0
Total number core boxes	32
Date hole	Started 23 OCT., 1964 / Completed 7 NOV., 1964
Elevation top of hole	1666'
Total core recovery for boring	470.4' 100 %

Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
	QUARTZ DIORITE: HARD, FINE TO MED. GR., WHITE & BLACK; LT. WEA.		7	CORE LENGTHS TO 2.1' 100% W.R., GRAY
110			109.7	
	LT. CHEM. ALT.		8	CORE LENGTHS TO 0.6' 100% W.R., GREEN
120	BASALT: MOD. SOFT, FINE GR., MOD. WEA., GRAY GREEN, SLIGHTLY VESICULAR			
			124.5	100% W.R., GRAY, WHITE CORE LENGTHS TO 2.3'
130	DIORITE: MOD. HARD, FINE GR.		9	CORE LENGTHS TO 7.9'
140			139.4	
150		100	10	
			154.2	
160	CHEM. ALT. ZONE		11	
170			168.8	
	SOME WHAT FRACTURED		12	CORE LENGTHS TO 2.1'
	CHEM. ALT. ZONES		183.5	
190	DIORITE: MOD. HARD, MED. GR., BLACK, WHITE, GRAY, GREEN		13	
200	CHEM. ALT. ZONES; QTZ. DOMINANT		198.3 / 14	

NOTE:
SEE LOG RECORDS NUMBER 1 FOR NOTES AND LEGEND.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm. B. Trautwein	SNETTISHAM PROJECT, ALASKA FIRST STAGE DEVELOPMENT
DRAWN: Wm. B. Trautwein	
CHECKED: D. Hansen	LOG RECORD NO. 8
PREPARED:	
SUPERVISED: N. A. Dixon, CHIEF, SECTION	APPROVED: [signature], COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: [signature], CHIEF, FOUNDATIONS & MATERIALS BRANCH	SCALE / DATE 20 Oct 65
RECOMMENDED: Warren George, CHIEF, ENGINEERING DIVISION	FILE NUMBER / SHEET OF

2

CORPS OF ENGINEERS

DRILLING LOG — Hole No. DH 25 (Sheet 3 of 5 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - MID TUNNEL
Location	N 100,098 E 93,330
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 25
Name of driller	DON SCHILL
Direction of hole	Inclined 70 — BEARING N 30° W
Thickness of overburden	2.3'
Depth drilled into rock	470.4'
Total depth of hole	472.7'
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12 B 401
Total no. of overburden samples taken	0 / 0
Total number core boxes	32
Date hole	Started 23 OCT., 1964 — Completed 7 NOV., 1964
Elevation top of hole	1665'
Total core recovery for boring	470.4' 100 %

Elevation	Depth	Classification of materials	% Core recov	Box or sample No.	Remarks
1585.5					CORE LENGTHS TO 7.6' 100% W.R., GRAY
		2" BRECCIA ZONE		14	
	210				CORE LENGTHS TO 1.6' 100% W.R., GRAY-GREEN
				213.2	
	220	FINE GR., GRAY GREEN, CHEM. ALT.		15	
				227.6	
	230				CORE LENGTHS TO 3.1' 100% W.R., GRAY
				16	
1573.0	240	QUARTZ DIORITE: HARD, MED. GR.; WHITE & BLACK; MASSIVE; FRESH.		242.6	
	250		100	17	CORE LENGTHS TO 5.4'
				257.3	
	260				CORE LENGTHS TO 10.0'
				18	
	270			272.3	
	280			19	
1566.5				287.1	
	290	DIORITE: MOD. HARD; MED. GR.; BLACK AND WHITE.		20	
1582.2	300				

DRILLING LOG — Hole No. DH 25 (Sheet 4 of 5 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - MID TUNNEL
Location	N 100,098 E 93,330
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 25
Name of driller	DON SCHILL
Direction of hole	Inclined 70' BEARING N 30°W
Thickness of overburden	2.3'
Depth drilled into rock	470.4'
Total depth of hole	472.7'
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12B 401
Total no. of overburden samples taken	0 / 0
Total number core boxes	32
Date hole	Started 23 OCT., 1964 — Completed 7 NOV., 1964
Elevation top of hole	1656'
Total core recovery for boring	470.4 100 %

Elevation	Depth	Classification of materials	% Core recov	Box or sample No.	Remarks
1562.2		DIORITE: MOD. HARD; MEDIUM GRAINED; BLACK AND WHITE; QTZ. INCLUSIONS COMMON.		301.7	CORE LENGHTS TO 10.1' 100% W.R., GRAY TO BROWN
	310	PYRITE CRYSTALS TO ¼" SIZE		21	CORE LENGTHS TO 6.8'
				316.9	
1545.5	320	QUARTZ DIORITE: HARD; COARSE TO MEDIUM GRAINED; WHITE AND BLACK; MASSIVE; FRESH.		22	
	330			331.6	
	340			23	
				346.5	
	350		100	24	
	360			361.0	
				25	
	370	DIORITE		376.0	
	380			26	
	390			390.7	
				27	
1519.0		DIORITE: (AS ABOVE)			
1518.0	400				

DRILLING LOG — Hole No. DH 25 (Sheet 5 of 5 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM - MID TUNNEL
Location	N 100,098 E 93,330
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 25
Name of driller	DON SCHILL, DON DUPUIS
Direction of hole	Inclined 70 BEARING N 30°W
Thickness of overburden	2.3'
Depth drilled into rock	470.4'
Total depth of hole	472.7'
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	JOY 12B 401
Total no. of overburden samples taken	0 / 0
Total number core boxes	32
Date hole	Started 23 OCT., 1964 — Completed 7 NOV., 1964
Elevation top of hole	1655'
Total core recovery for boring	470.4' 100 %

Elevation	Depth	Classification of materials	% Core recov	Box or sample No.	Remarks
1518.0		DIORITE: MOD. HARD; MED. GR.; BLACK & WHITE; MASSIVE; FRESH.		27	CORE LENGTHS TO 6.8' 100% W.R., GRAY
				407.6	
1515.0	410	LAMPROPHYRE DIKE; HARD, FINE GR.; DENSE; GRAY GREEN.		28	CORE LENGTHS TO 1.0' CORE LENGTHS TO 2.0' CORE LENGTHS TO 0.5'
	420	LAMPROPHYRE VEINS (AS ABOVE)		420.7	CORE LENGTHS TO 10.1'
				29	
1512.0	430	QUARTZ DIORITE: HARD; MED. GR.; WHITE & BLACK; SOFT, ALTERED, RUST STAINED MINERALOIDS ALONG OPEN FRACTURES. DIORITE	100	434.9	
	440			30	CORE LENGTHS TO 1.8'
		CHEM. ALT. ZONE			100% W.R., WHITE
	450	QTZ. DIKE		449.9	
				31	CORE LENGTHS TO 10.1' 100% W.R., GRAY
	460	DIORITE			
				464.4	
	470			32	
1493.4					

BOTTOM OF HOLE	1493.4'
DEPTH OF HOLE	472.7'
VERTICAL DEPTH	161.6'
HORIZONTAL DISTANCE	444.2'
THICKNESS OF O.B.	2.3'
ROCK CORED	470.4'
CORE RECOVERED	470.4'
% CORE RECOVERED	100%

DRILLING LOG — Hole No. DH 27 (Sheet 1 of 1 sheets)

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM POWER HOUSE
Location	N 94,810 E 93,100
Drilling agency	CORPS OF ENGINEERS
Hole No.	DH 27
Name of driller	LAWRENCE LARSON
Direction of hole	Inclined 48° 40' BEARING S 55° E
Thickness of overburden	74.6'
Depth drilled into rock	0.0'
Total depth of hole	74.6'
Size and type of bit	NX
Datum for elevation shown	MSL
Manufacturer's designation of drill	SULLIVAN 22 HD
Total no. of overburden samples taken	0 / 0
Total number core boxes	0
Date hole	Started 11 NOV., 1964 — Completed 18 NOV., 1964
Total core recovery for boring	0 0 %

Elevation	Depth	Classification of materials	% Core recov	Box or sample No.	Remarks
		SILT, ORGANIC, BLACK			CHOPPED, WASHED, ROCK BITTED. CONSIDERABLE DIFFICULTY WITH BINDING OF CASING DUE TO BOULDERS SHIFTING DOWN INTO CASING - USED 40' OF NX CASING. 73' OF BX CASING.
	10	SAND, FINE, GREENISH-GRAY, WITH OCCASIONAL PEBBLES COBBIES AND BOULDERS			
	20				
	30	CLAY, SILTY, LEAN, GRAY			
		BOULDER			
	40	SAND, COARSE TO FINE; OCCASIONAL PEBBLES, COBBLES AND BOULDERS			
	50				
	60				
	70	BOULDERS, FINE GRAY INTERSTIAL SAND			

DEPTH OF HOLE	74.6'
VERTICAL DEPTH	49.4'
HORIZONTAL DISTANCE	55.7'

DRILLING LOG — Hole No. DH 26 — Sheet 1 of 2 sheets

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM POWER HOUSE
Location	N 94,828 E 93,085
Size and type of bit	NX
Datum for elevation shown	MSL
Drilling agency	CORPS OF ENGINEERS
Manufacturer's designation of drill	SULLIVAN 22 HD
Hole no.	DH 26
Total no. of overburden samples taken	0 (Disturbed) 0 (Undisturbed)
Name of driller	LAWRENCE LARSON
Total number core boxes	10
Direction of hole	Vertical, 0 deg. from vert.
Elevation ground water	20.0'
Date hole	Started 31 OCT., 1964 Completed 9 NOV., 1964
Thickness of overburden	16.0'
Elevation top of hole	61.2'
Depth drilled into rock	135.1'
Total core recovery for boring	135.1' 100%
Total depth of hole	151.1'

Elevation	Depth	Legend	Classification of Materials	% Core Recovery	Box or Sample No.	Remarks
			SANDY SILT: ORGANIC, PEATY			4" CASING TO 2.9' NX CASING TO 20.0' BLACK WATER RETURN
	10		BOULDERS			
	20		DIORITE AND QTZ. DIO. HARD MED. GR. WHITE & BLACK GNEISSIC BANDING. LT. WEA. OCC. QTZ. FELDSPAR SEAMS			CORE LENGTHS TO 4.7'
					1	
	30				30.4	CORE LENGTHS TO 4.1'
	40				2	CORE LENGTHS TO 1.3'
					45.2	
	50				3	
				100		CORE LENGTHS TO 3.0'
	60				60.1	CORE LENGTHS TO 9.9'
	70				4	
					75.1	
	80				5	
	90				90.1	CORE LENGTHS TO 1.6'
			LT. WEA., RUST STAINED		6	
-38.8	100					

DRILLING LOG — Hole No. DH 26 — Sheet 2 of 2 sheets

Division	NORTH PACIFIC
Installation	ALASKA
Project	SNETTISHAM POWERHOUSE
Location	N 94,828 E 93,085
Size and type of bit	NX
Datum for elevation shown	MSL
Drilling agency	CORPS OF ENGINEERS
Manufacturer's designation of drill	SULLIVAN 22 HD
Hole no.	DH 26
Total no. of overburden samples taken	0 (Disturbed) 0 (Undisturbed)
Name of driller	LAWRENCE LARSON
Total number core boxes	10
Direction of hole	Vertical, 0 deg. from vert.
Elevation ground water	20.0
Date hole	Started 31 OCT., 1964 Completed 9 NOV., 1964
Thickness of overburden	16.0'
Elevation top of hole	61.2'
Depth drilled into rock	135.1'
Total core recovery for boring	135.1' 100%
Total depth of hole	151.1'

Elevation	Depth	Legend	Classification of Materials	% Core Recovery	Box or Sample No.	Remarks
			DIORITE AND QTZ. DIORITE AS BEFORE, BUT WITH RAN SOM QTZ. SEAMS		6	CORE LENGTHS TO 10.1'
					104.5	100% W.R., GRAY
	110				7	
			QTZ. SEAMS COMMON			
	120				119.9	
				100	8	
	130					
					134.4	
	140				9	
					149.4	
-89.9	151				10	
			BOTTOM OF HOLE EL. -89.9' DEPTH OF HOLE 151.1' THICKNESS OF O.B. 16.0' ROCK CORED 135.1' CORE RECOVERED 135.1' % CORE RECOVERED 100			20' NX CASING LEFT IN HOLE

NOTE:
SEE LOG RECORDS NUMBER 1 FOR NOTES AND LEGEND

Revision	Date	Description	By

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm. B. Trautwein	SNETTISHAM PROJECT, ALASKA FIRST STAGE DEVELOPMENT
DRAWN: Wm. B. Trautwein	
CHECKED: D. Hunter	
PREPARED: CHIEF	LOG RECORD NO. 9
SUPERVISED: N. R. Dixon, CHIEF GEOLOGY SECTION	APPROVED: Clare J. Farley, COLONEL, CE DISTRICT ENGINEER
SUBMITTED: Roland B. [illegible], CHIEF FOUNDATIONS & MATERIALS BRANCH	SCALE — DATE 20 Oct 65
RECOMMENDED: Warren George, CHIEF ENGINEERING DIVISION	FILE NUMBER — SHEET OF

AD-A067 895 CORPS OF ENGINEERS ANCHORAGE AK ALASKA DISTRICT F/G 13/2

SNETTISHAM PROJECT ALASKA. FIRST STAGE DEVELOPMENT. DESIGN MEMO--ETC(U)

OCT 65

UNCLASSIFIED NL

6 OF 6

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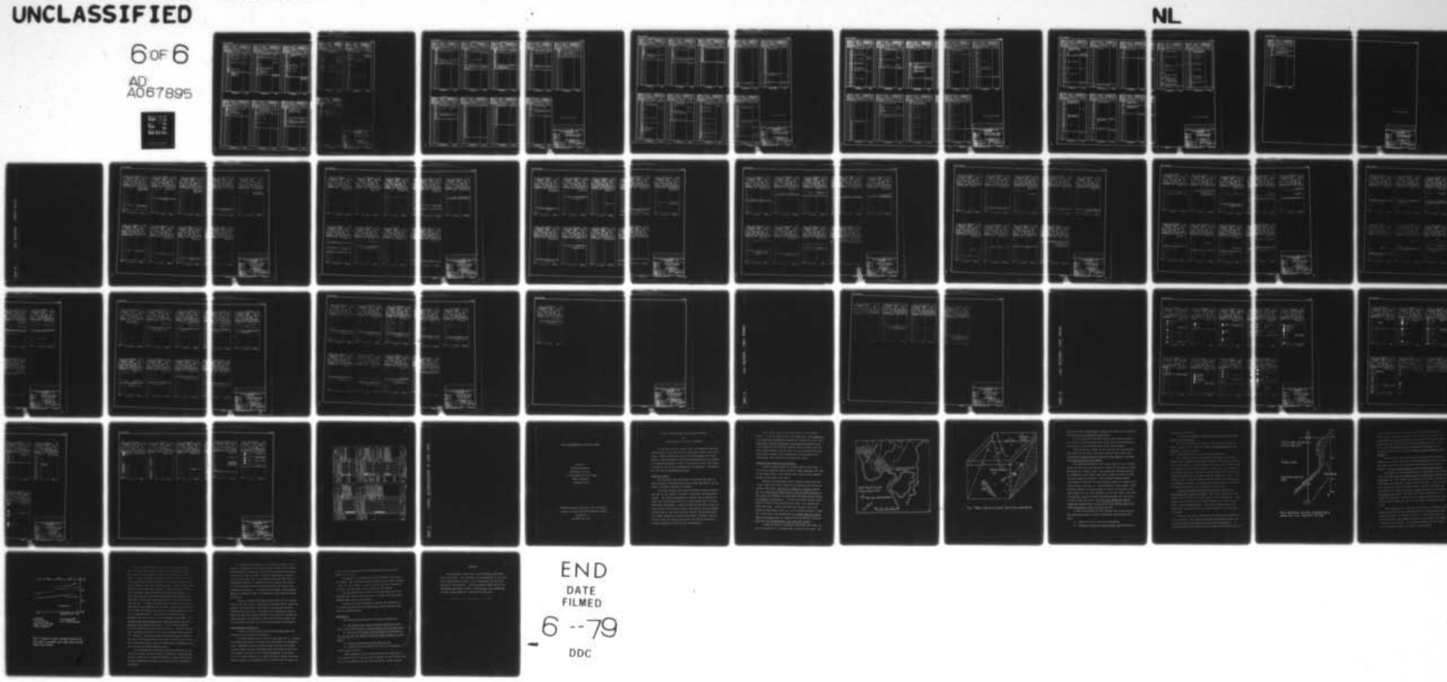

END

DATE FILMED

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DDC

DEPTH OF HOLE [illegible] OF O.B. [illegible] DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC. [illegible] DATE STARTED [illegible]
AZIMUTH HOLE ____ HADE 0 DATE COMPLETED [illegible]
INITIALS WBT CONTRACT NO. ____

SURFACE EL. [illegible] HOLE NO 28 N 103,325 E 95,280

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
825.[illegible]		SILT, ORGANIC, BLACK	DUG TO TOP OF [illegible]
		QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, WHITE AND BLACK, RUST STAINED JOINTS [illegible]	100% W.R. TO [illegible] TEMPORARY WATER LOSS AT [illegible]
		JOINTS OPEN, DIRT & RUST FILLED.	GRADUALLY INCREASING TO 50% AT 20'
812.4		QUARTZ DIORITE, MASSIVE, FRESH	WATER LEVEL - 11 JUN 65
	20	GNEISSIC BANDING	
800.1		" OPEN JOINT, WEATHERED (IRREGULAR OPEN FROM 1/32" to 1/4")	LOST DRILL WATER AT 25.5'
	30		
	40	SLIGHTLY WEATHERED.	
		OPEN JOINT - RUST STAINED	
775.0	50	BOTTOM OF HOLE EL. 775.0 DEPTH OF HOLE 50.9' THICKNESS OF O.B. 0.6' ROCK CORED 50.3' CORE RECOVERED 48.5' % CORE RECOVERED 96.4	

SNETTISHAM
SITE AND PROJECT
DH-28
HOLE NO.

DEPTH OF HOLE [illegible] OF O.B. [illegible] DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC. [illegible] DATE STARTED 10 June 65
AZIMUTH HOLE ____ HADE 0 DATE COMPLETED [illegible]
INITIALS WBT CONTRACT NO. ____

SURFACE EL. 830.0 HOLE NO 29 N 103,336 E 95,263

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
830.[illegible]		MOSSY TURF, ORGANIC, BLACK	
		QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, WHITE AND BLACK, LIGHTLY WEATHERED.	100% W.R., GRAY TO MILKY WHITE. CORE LENGTHS 0.1' TO 5.5'
	10	RUST STAINED JOINTS.	
		FOLIDATION PARTINGS, PERPENDICULAR TO FOLIATION, ALL ARE WEATHERED.	LOST DRILL. WATER RETURN AT 13' +
	20		W.T. AT 807.6' EL 12 JUNE 1965
801	30		
	40	FOLIATION PARTINGS, DIPS 40-75° GROUND, RUST COATED JOINT PERPENDICULAR TO FOLIATION PARTINGS.	
	50	MOD HARD, MOD WEATHERED. RUST STAINED. GROUND PARTINGS. CORE LOSS.	
775	55		NOTE: PRESSURE TESTING DISCONTINUED DUE TO CAVE.

SNETTISHAM
SITE AND PROJECT
DH-29
HOLE NO.

DEPTH OF HOLE [illegible] OF O.B. [illegible] DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC. [illegible] DATE STARTED 14 Jun 65
AZIMUTH HOLE ____ HADE 0 DATE COMPLETED [illegible]
INITIALS WBT CONTRACT NO. ____

SURFACE EL. 834.6 HOLE NO 30 N 103,319 E 95,252

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
834.6		QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, WHITE AND BLACK, LIGHTLY WEATHERED. OCCASIONAL QTZ. SEAMS	100% WATER RETURN GRAY TO WHITE
	10	OPEN JOINT LT WEA	LOST DRILL WATER AT EL 825.7
	20		
	30	JOINT, RUST STAINED.	W.T., EL 808 15 JUNE 1965
799.9		JOINT, LIGHTLY RUST STAINED	
	40	JOINT, 70° RUST STAINED.	
		JOINT 68° WEATHERED.	
	50		
774.2			NOTE: HOLE NOT TESTED BELOW 42.8 DUE TO POSSIBLE ROCK CAVE JAMMING PACKER.

SNETTISHAM
SITE AND PROJECT
DH-30
HOLE NO.

DEPTH OF HOLE 122.7 OF O.B. 0.6 DIAMETER OF HOLE NX
ROCK DRILLED 122.1 % REC. 98.3 DATE STARTED 12 JUNE 65
AZIMUTH HOLE S 10° E HADE 45° DATE COMPLETED 19 JUNE 65
INITIALS WBT CONTRACT NO. ____

SURFACE EL. 829.2 HOLE NO 32 N 103,294 E 95,262

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		CLOSELY JOINTED, DIPS 22° - 77° LT. WEA. RUST STAINED	NO DRILL WATER RETURN
	110	HIGHLY WEATHERED, CHEM ALTER. RUST STAINS.	
750		CLAY SEAM, SOFT	
		JOINT, RUST STAINED, OPEN.	
		MOD. HARD, RUST STAINED.	
	120		
742.4			

SNETTISHAM
SITE AND PROJECT
DH-32
HOLE NO.

DEPTH OF HOLE 52.7 OF O.B. 4.0 DIAMETER OF HOLE NX
ROCK DRILLED 48.7 % REC. 99.0 DATE STARTED 24 Jun 65
AZIMUTH HOLE ____ HADE 0 DATE COMPLETED [illegible]
INITIALS WBT CONTRACT NO. ____

SURFACE EL. 827.9 HOLE NO 33 N 103,262 E 95,248

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
828		SANDY GRAVEL, WITH COBBLES,& ORGANIC SILT COVERING.	
823.9		QUARTZ DIORITE - CL. JOINTED, HARD, MEDIUM TO COARSE GRAINED, WHITE AND BLACK, WEATHERED ALONG JOINTS.	100% WATER RETURN, GRAY.
	10	JOINTS OPEN, RUST STAINED, DIP 12 - 42°	LOST DRILL WATER EL. 815
		HIGH ANGLE WEATHERED JOINTING 75° - 80° DIP	WATER LEVEL 26 Jun 65
	20	MOD WEA, DIP 18° - 21°	
800	30	DIP 11°, WEATHERED.	
	40	WEATHERED, DIPS 15° to 16°	
	50		
775.2			

SNETTISHAM
SITE AND PROJECT
DH-33
HOLE NO.

DEPTH OF HOLE 47.6 OF O.B. 36.8 DIAMETER OF HOLE NX
ROCK DRILLED 10.6 % REC. 100 DATE STARTED 30 Jun 65
AZIMUTH HOLE ____ HADE 0 DATE COMPLETED [illegible]
INITIALS WBT CONTRACT NO. ____

SURFACE EL. 5.6 HOLE NO 34 N 94,671 E 93,215

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
5.6		SILT, ORGANIC, BROWN.	
		DARK GRAY	
		SAND, GRAVELLY, FINE TO COARSE	
	10	GRAVEL, SANDY, OCCASIONAL COBBLES & BOULDERS.	
	20		
-31		SAND, OCCASIONAL PEBBLES	MATERIAL CLASSIFIED BY DRIVE & WASH SAMPLES.
	30	GRAVEL, SANDY.	
		TOP OF ROCK.	START OF NX CORE
-31		QUARTZ DIORITE, HARD, MEDIUM TO FINE GRAINED, BLACK & WHITE, LT WEA, HIGHLY JOINTED.	100% DRILL WATER RETURN - GRAY.
	40	JOINT, WITH SLICKS	
-41	47.6		

SNETTISHAM
SITE AND PROJECT
DH-34
HOLE NO.

U. S. ARMY

DEPTH OF HOLE	DIAMETER OF HOLE
ROCK DRILLED	DATE STARTED
AZIMUTH HOLE	DATE COMPLETED
INITIALS	CONTRACT NO.
SURFACE EL.	HOLE NO.

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				QUARTZ DIORITE, HARD, MEDIUM TO COARSE GRAINED, WHITE AND BLACK, LIGHTLY WEATHERED, RUST STAINED FRACTURES AND JOINTS COMMON.	100% WATER RETURN, GRAY
					LOSS TO 0.7' LENGTHS
				WEATHERED JOINTING	SMALL WATER TURNED BROWN AND LOST IN THIS INTERVAL.
					NO WATER RETURN.
				JOINT, LIGHTLY WEATHERED.	
				JOINTS, LIGHTLY WEATHERED, RUST STAINED.	

SNETTISHAM
SITE AND PROJECT

DH-31
HOLE NO.

DEPTH OF HOLE	DIAMETER OF HOLE
ROCK DRILLED	DATE STARTED
AZIMUTH HOLE	DATE COMPLETED
INITIALS	CONTRACT NO.
SURFACE EL.	HOLE NO.

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				QUARTZ DIORITE, MED HARD, MEDIUM TO COARSE GRAINED, WHITE & BLACK, JOINTED TO MASSIVE, WEATHERED.	
				JOINT, OPEN TO 1/2", RUST STAINED.	LOST DRILL WATER AT EL. 821 GRADUALLY RETURNED TO 100% THEN LOST WATER AROUND EL. 815
				JOINT WEA., RUST STAINED.	
				SOFT, LIGHTLY WEATHERED, ZONE OF CORE LOSS, GROUND BREAKS.	
	40			JOINT, LT WEA	
				JOINT, OPEN, RUST STAINED.	
	70			JOINT, WEATHERED, RUST STAINED.	

SNETTISHAM
SITE AND PROJECT

DH-32
HOLE NO.

DEPTH OF HOLE	DIAMETER OF HOLE
ROCK DRILLED	DATE STARTED
AZIMUTH HOLE	DATE COMPLETED
INITIALS	CONTRACT NO.
SURFACE EL. 4.3	HOLE NO.

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
4.3				SILT, DARK GRAY	MATERIAL DETERMINED FROM DRIVE & WASH SAMPLES.
	10			GRAVELLY SAND, OCCASIONAL COBBLES	
				SANDY GRAVEL, ROCKS, COBBLES AND BOULDERS.	
-14.5	20			TOP OF ROCK.	
				QUARTZ DIORITE - HARD	100% WATER RETURN DARK GRAY
				DIORITE - MED. HARD, FINE TO MEDIUM GRAINED, BLACK AND WHITE, LT. WEATHERED JOINTING.	
-24.2					

SNETTISHAM
SITE AND PROJECT

HOLE NO.

NOTE:
SEE LOG RECORD NUMBER 1 FOR NOTES AND LEGEND

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORDS NO. 10

DESIGNED:
DRAWN:
CHECKED: D. Hansen
PREPARED:
SUPERVISED:
SUBMITTED:
FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED:
APPROVED:
SCALE:
DATE: 20
FILE NUMBER:
SHEET OF

2

CORPS OF ENGINEERS

DEPTH OF HOLE [illegible] OF OB [illegible] DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC [illegible] DATE STARTED [illegible] Jul 65
AZIMUTH HOLE HADE DATE COMPLETED [illegible]
INITIALS [illegible] CONTRACT NO

SURFACE EL. 3.2 HOLE NO 36 N 94,682 E 93,118

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
3.2				SILT, DARK GRAY	MATERIAL DETERMINED BY DRIVE & WASH SAMPLES.
				SANDY GRAVEL, COBBLES OCCASIONAL TO COMMON, OCCASIONAL BOULDER.	
-23.2				TOP OF ROCK	START NX CORE
				QUARTZ DIORITE - HARD, MEDIUM GRAINED, WHITE & BLACK.	100% DRILL WATER RETURN - GRAY
				DIORITE _ MOD. HARD GRAY BLACK.	
-33.4	36.6				

SNETTISHAM
SITE AND PROJECT

DH-36
HOLE NO.

(OFFICE USE ONLY)

DEPTH OF HOLE [illegible] OF OB [illegible] DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC [illegible] DATE STARTED 7 Jul 65
AZIMUTH HOLE HADE 0 DATE COMPLETED [illegible]
INITIALS [illegible] CONTRACT NO

SURFACE EL. 1.5 HOLE NO 37 N 94,615 E 93,147

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
1.5				SILT, DARK GRAY, SOMEWHAT ORGANIC	
				SANDY GRAVEL, SAND COARSE TO FINE, GRAVEL TO COBBLE SIZE, CHIEFLY FINE.	MATERIAL DETERMINED BY DRIVE & WASH SAMPLES IN OVERBURDEN.
				GRAVELLY SAND, OCCASIONAL COBBLE.	
				SANDY GRAVEL	
-39.9				COBBLEY GRAVEL	TOP OF ROCK.
				DIORITE --HARD, MED GRAIN, BLACK & WHITE, LIGHTLY WEATHERED JOINTS.	100% DRILL WATER RETURN, GRAY, BROWN GRAY BELOW 47.5' DEPTH.
				JOINTS, SLICKENSIDES. DIP 50° to 72°.	
-49.8					

SNETTISHAM
SITE AND PROJECT

DH-37
HOLE NO.

(OFFICE USE ONLY)

DEPTH OF HOLE [illegible] OF OB [illegible] DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC 90 DATE STARTED 9 Jul 65
AZIMUTH HOLE HADE 0 DATE COMPLETED [illegible]
INITIALS [illegible] CONTRACT NO

SURFACE EL. 4.9 HOLE NO 38 N 94,623 E 93,026

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
4.9				SILT, ORGANIC, BLACK.	MATERIAL DETERMINED BY DRIVE & WASH SAMPLES IN OVERBURDEN.
				SILT, DARK GRAY	
				SANDY GRAVEL, COBBLES COMMON.	100% W.R., BROWN.
-34.3				TOP OF ROCK	START NX CORING.
				QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, WHITE & BLACK.	100% W.R., GRAY BROWN W.R.
				OPEN RUST STAINED JOINT.	
				DIORITE - HARD, MEDIUM GRAINED, BLACK & WHITE.	
-44.1	49.0				

SNETTISHAM
SITE AND PROJECT

DH-38
HOLE NO.

(OFFICE USE ONLY)

DEPTH OF HOLE [illegible] OF OB [illegible] DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC 100 DATE STARTED 16 Jul 65
AZIMUTH HOLE HADE 0 DATE COMPLETED [illegible]
INITIALS [illegible] CONTRACT NO

SURFACE EL. 46.9 HOLE NO DH-41 N 94,759 E 93,280

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
46.9				TOP SOIL - ORGANIC, HUMUS	
				GRAVELLY SAND - RUST BROWN	MATERIAL DETERMINED BY DRIVE & WASH SAMPLES IN OVERBURDEN
				SILTY SAND, GRAY GREEN	
				GRAVELLY SAND	
23.8				QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, WHITE & BLACK, MASSIVE, FOLIATION INDISTINCT.	100% DRILL WATER RETURN, GRAY
8.6					

SNETTISHAM
SITE AND PROJECT

DH-41
HOLE NO.

DEPTH OF HOLE 84.8 OF OB 84.8 DIAMETER OF HOLE NX
ROCK DRILLED 0 % REC - DATE STARTED 19 Jul 65
AZIMUTH HOLE HADE 0 DATE COMPLETED [illegible]
INITIALS D.E.H. CONTRACT NO

SURFACE EL. 49.2 HOLE NO DH-42 N 94,772 E 93,118

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				FOREST LITTER, MOSS LEAVES, ETC	MATERIAL DETERMINED BY DRIVE AND WASH SAMPLES.
				SAND, GRAVEL, COBBLES AND BOULDERS	
-36					NO SAMPLES SAVED

SNETTISHAM (POWERHOUSE)
SITE AND PROJECT

DH-42
HOLE NO.

DEPTH OF HOLE [illegible] OF OB [illegible] DIAMETER OF HOLE NX
ROCK DRILLED 0 % REC -- DATE STARTED 27 July 1965
AZIMUTH HOLE HADE 0° DATE COMPLETED [illegible] July 1965
INITIALS D.E.H. CONTRACT NO

SURFACE EL. 15.5 HOLE NO DH-43 N 94,734 E 93,095

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				PEAT, BROWN AND BLACK	MATERIAL DETERMINED BY DRIVE AND WASH SAMPLES
				SAND, GRAVEL, COBBLES AND BOULDERS	
-37					NO SAMPLES SAVED

SNETTISHAM (POWERHOUSE)
SITE AND PROJECT

DH-43
HOLE NO.

DEPTH OF HOLE 51.1 OF O.B. 41.1
ROCK DRILLED 10.1 % REC. 100
AZIMUTH HOLE ____ HADE 0
INITIALS WRT
DIAMETER OF HOLE NX
DATE STARTED 10 Jul 63
DATE COMPLETED [illegible]
CONTRACT NO. ____

SURFACE EL. 5.5 — HOLE NO 39 — N 94,674, E 93,057

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
5.5				SILT, ORGANIC, GRAY BLACK	MATERIAL DETERMINED BY DRIVE & WASH SAMPLES IN OVER-BURDEN
				GRAVELLY SAND, SAND IS FINE TO COARSE.	
	10			SANDY GRAVEL, COBBLES COMMON, OCCASIONAL BOULDER.	
	20				
	30				
-35.5	40			TOP OF ROCK	
				QUARTZ DIORITE - HARD, MEDIUM GRAINED, WHITE & BLACK, LIGHT STAINING.	100% DRILL WATER RETURN, GRAY
-45.6	50				

SNETTISHAM — SITE AND PROJECT — DH-39 — HOLE NO.

DEPTH OF HOLE 17.8 OF O.B. 4.5
ROCK DRILLED 13.3 % REC. 98.5
AZIMUTH HOLE ____ HADE 0
INITIALS WBT
DIAMETER OF HOLE NX
DATE STARTED 16 Jul 63
DATE COMPLETED [illegible]
CONTRACT NO. ____

SURFACE EL. 6.6 — HOLE NO 40 — N 94,698, E 93,119

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
6.6				SILTY SAND, SOME GRAVEL, BROWN.	TOP OF ROCK.
2.1				DIORITE - MOD. HARD, MEDIUM GRAINED BLACK. WHITE QTZ SEAMS COMMON.	
	10			QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, WHITE & BLACK	100% DRILL WATER RETURN - GRAY
				JOINT, SLICKS	
-11.2	17.8				

SNETTISHAM — SITE AND PROJECT — DH-40 — HOLE NO.

DEPTH OF HOLE 28.6 OF O.B. 12.2
ROCK DRILLED 16.4 % REC. 99.8
AZIMUTH HOLE ____ HADE 0
INITIALS D.J.H.
DIAMETER OF HOLE NX
DATE STARTED 2 Aug 65
DATE COMPLETED [illegible]
CONTRACT NO. ____

SURFACE EL. 11.5 — HOLE NO DH-44 — N 94,706, E 93,053

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				FOREST LITTER, MOSS, LEAVES, ETC	NO SAMPLES SAVED
				SAND, GRAVEL, COBBLES AND BOULDERS	
-1	10			TOP OF ROCK	
	20			QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, WHITE AND BLACK, LIGHTLY WEATHERED, MASSIVE	START OF NX CORE 100% DRILL WATER RETURN
-17	30				1 BOX OF CORE

SNETTISHAM (POWERHOUSE) — SITE AND PROJECT — DH-44 — HOLE NO.

NOTE:
SEE LOG RECORD NUMBER 1 FOR NOTES AND LEGEND

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: W. B. Trautwein
DRAWN: WBT DEH
CHECKED: D. J. Laurel
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORDS NO. 11

SUPERVISED: M. Dixon — CHIEF, GEOLOGY SECTION
SUBMITTED: [illegible] — CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: [illegible] — CHIEF, ENGINEERING DIVISION
APPROVED: [illegible] — COLONEL, CE, DISTRICT ENGINEER
SCALE — DATE: 20 Oct 65
FILE NUMBER
SHEET OF

2

CORPS OF ENGINEERS

(OFFICE USE ONLY)

DEPTH OF HOLE [illegible] OF O.B. [illegible] DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC. [illegible] DATE STARTED [illegible] Aug 65
AZIMUTH HOLE [illegible] HADE [illegible] DATE COMPLETED [illegible]
INITIALS [illegible] CONTRACT NO.

SURFACE EL. [illegible] HOLE NO DH-45 N [illegible] E [illegible]

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		FOREST LITTER, LEAVES, MOSS, PEAT	NO O.B. SAMPLES SAVED
		SAND, GRAVEL, COBBLES AND BOULDERS	
11	20	TOP OF ROCK	
		QUARTZ DIORITE - HARD, MEDIUM GRAINED, JOINTED TO MASSIVE, LIGHTLY WEATHERED FOR 2.5 FEET, BLACK AND WHITE	100 TO 30% WATER RETURN
-1	30		1 BOX OF CORE

DEPTH OF HOLE [illegible] OF O.B. [illegible] DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC. [illegible] DATE STARTED 30 Aug 65
AZIMUTH HOLE [illegible] HADE [illegible] DATE COMPLETED [illegible]
INITIALS [illegible] CONTRACT NO.

SURFACE EL. 52.0 HOLE NO DH-46 N 94,749 E 93,338

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		FOREST LITTER, LEAVES, MOSS, PEAT ETC.	MATERIALS DETERMINED BY WASH SAMPLES AND CUTTINGS
	10	SAND, GRAVEL, COBBLES AND BOULDERS	
21	30	TOP OF ROCK	START NX CORE
		QUARTZ DIORITE - MODERATELY HARD TO HARD, FINE TO MEDIUM GRAINED, JOINTED TO MASSIVE, BLACK & WHITE	60 TO 80% WATER RETURN
	40		1 BOX OF CORE

(OFFICE USE ONLY)

DEPTH OF HOLE 38.5 OF O.B. 38.5 DIAMETER OF HOLE [illegible]
ROCK DRILLED 0 % REC. [illegible] DATE STARTED [illegible] Aug 65
AZIMUTH HOLE [illegible] HADE 0 DATE COMPLETED [illegible]
INITIALS [illegible] CONTRACT NO.

SURFACE EL. 26.8 HOLE NO DH-47 N 94,700 E 93,327

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		FOREST LITTER, LEAVES, MOSS, ETC.	MATERIALS DETERMINED BY WASH SAMPLES AND CUTTINGS
		SAND, GRAVEL, COBBLES AND BOULDERS	
-13	40		NO SAMPLES SAVED

DEPTH OF HOLE 100.0 OF O.B. 0.0 DIAMETER OF HOLE NX
ROCK DRILLED 100.0 % REC. 99.6 DATE STARTED 25 Aug 65
AZIMUTH HOLE - HADE 0 DATE COMPLETED 30 Aug 65
INITIALS D.E.R. CONTRACT NO.

SURFACE EL. 829.6 HOLE NO DH-49 N 103,434 E 95,389

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
829.6		DIORITE - MOD. HARD, MEDIUM GRAINED, GRAY-BLACK	100% DRILL WATER RETURN, GREEN GRAY
	10	QUARTZ DIORITE - HARD, MEDIUM GRAINED, WHITE AND BLACK, MASSIVE	K 46
			LOST DRILL WATER
	20		NO CASING USED K 28
	30		K 0
	40	JOINTS 18°, 12° SLIGHTLY WEATHERED	K 23
	50		K 19
	60	JOINTS, [illegible]° - 18° WEATHERED	WATER LOSS
			K 0
	70	ZONE OF JOINTING 11° - 82° WEATHERED & RUST STAINED	
		MOD WEATHERED, RUST MOD SOFT	K 8.5
	80		K 0
	90		K 0
729.6	100	BOTTOM OF HOLE	9

DEPTH OF HOLE 50.8 OF O.B. 0.0 DIAMETER OF HOLE NX
ROCK DRILLED 50.8 % REC. 98.8 DATE STARTED 31 Aug 65
AZIMUTH HOLE 0 HADE 0 DATE COMPLETED 2 Sep 65
INITIALS WBT CONTRACT NO.

SURFACE EL. 830.8 HOLE NO DH-50 N 103,435 E 95,368

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
830.8		DIORITE - MOD. HARD, MEDIUM GRAINED, GRAY BLACK	100% W.R. (DRILL WATER RETURN) GRAY
		QUARTZ DIORITE - HARD MEDIUM GRAINED, WHITE AND BLACK	
	10	JOINTS 52 & 58° WEATHERED AND STAINED.	K 50
			LOST DRILL WATER EL. 815
	20		K 12
		OPEN FISSURE OR CLAY FILLED JOINT	0.5' VERY FAST PENETRATION
	30	ZONE OF MOD WEATHERING, RUST STAINING ALONG HIGH ANGLE JOINTS	
		JOINTS 18 - 46° LIGHT WEATHERING	K 29
	40		K 0.5
780	50	CLOSE JOINTS 11° - 37°, LT WEA	

DEPTH OF HOLE 99.9 OF O.B. 0.0 DIAMETER OF HOLE NX
ROCK DRILLED 99.9 % REC. 100 DATE STARTED 6 Sep 65
AZIMUTH HOLE - HADE 0 DATE COMPLETED 9 Sep 65
INITIALS WBT CONTRACT NO.

SURFACE EL. 828.5 HOLE NO DH-51 N 103,415 E 95,385

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
828.5		QUARTZ DIORITE - HARD, MEDIUM GRAINED, WHITE AND BLACK, OCCASIONAL SEAMS OF MOD HARD GRAY BLACK DIORITE	100% DRILL WATER RETURN, WHITE-GRAY
	10		LOST DRILL WATER AT EL 814.7
		OPEN FRACTURES	K 45+
		JOINT, RUST STAINED.	
	20	MOD WEA	K 47+
		JOINT RUST STAINED	K 0
	30		
	40		K 0.7
		OPEN FRACTURES, LIGHT WEATHERED	K 22
	50		
		JOINTS, OPEN, LIGHTLY WEATHERED 12 - 20°	K 18
	60	MOD WEA, OPEN	
			K 6.0
	70	JOINT, WEA, RUST STAINED	
			K 6.2
	80	JOINT OPEN, FILLED ½" WITH RESIDUAL ROTTEN - DIORITE	
		ZONE OF JOINTS, WEA, RUST STAINED, DIPS 3° - 70°	K 0.13
	90	JOINTS WITH ½" - 3/4", RUST STAINED DIORITE SEAM, MOD SOFT	
		BOTTOM	K 0.1
	99.9		10

725

813.9

803

767

727.

DEPTH OF HOLE 189.1 OF OB 22.0 DIAMETER OF HOLE NX
ROCK DRILLED 22.1 % REC 29.6 DATE STARTED
AZIMUTH HOLE - HADE 0° DATE COMPLETED
INITIALS CONTRACT NO.

SURFACE EL. 815.3 HOLE NO DH-48 N 103,353 E 95,175

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
	0–90			WATER - LONG LAKE	
	90–100			SILT, SAND, GRAVEL, BOULDERS, TREES, BRANCHES AND OTHER DEBRIS	

SNETTISHAM (LONG LAKE D.S.) — SITE AND PROJECT
DH-48 — HOLE NO.

DEPTH OF HOLE 189.1 OF OB 22.0 DIAMETER OF HOLE NX
ROCK DRILLED 22.1 % REC 29.6 DATE STARTED
AZIMUTH HOLE - HADE 0° DATE COMPLETED
INITIALS D.E.H. CONTRACT NO.

SURFACE EL. 815.3 HOLE NO DH-48 N 103,353 E 95,175

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
	100–167			SILT, SAND, GRAVEL, BOULDERS, TREES BRANCHES AND OTHER DEBRIS	
648	167			TOP OF ROCK	
	167–189			QUARTZ DIORITE - HARD, FINE TO COARSE GRAINED, MASSIVE	K 0.0
626	189			BOTTOM OF HOLE	1 BOX OF CORE

SNETTISHAM (LONG LAKE D.S.) — SITE AND PROJECT
DH-48 — HOLE NO.

DEPTH OF HOLE 86.9 OF OB 35.8 DIAMETER OF HOLE NX
ROCK DRILLED 50.1 % REC 100 DATE STARTED 6 Sep 65
AZIMUTH HOLE HADE 0 DATE COMPLETED Sep 65
INITIALS WBT CONTRACT NO.

SURFACE EL. 813.9 HOLE NO DH-52 N 103,517 E 95,319

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
813.9	0–10			WATER	
	10–46			BOULDERS, COBBLES AND GRAVELS WITH INTERSTIAL SILT AND SAND	
	46				TOP OF ROCK
	46–86.9			QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, WHITE AND BLACK, OCCAS QUARTZ FELDSPAR AND DIORITE ZONES	
				JOINT, LT RUST STAINED	
				JOINTING, MOD WEA, RUST STAINED	BROWN WATER RETURN THEN LOSS EL 751.4
				FRESH, MASSIVE	K 0
	86.9				100% DRILL WATER RETURN, WHITE-GRAY

SNETTISHAM — SITE AND PROJECT
DH-52 — HOLE NO.

NOTE:
SEE LOG RECORD NUMBER 1 FOR NOTES AND LEGEND

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm B Trautwein
DRAWN: WBT DEH
CHECKED:
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORDS NO. 12

SUPERVISED: M E Dixon — CHIEF, GEOLOGY SECTION
SUBMITTED: Roland B Jones — CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George — CHIEF, ENGINEERING DIVISION
APPROVED: — COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

2

CORPS OF ENGINEERS

HOLE NO DH-53

SURFACE EL. 820.4 | N 103,210 | E 95,165

ELEVATIONS	DESCRIPTION OF MATERIALS	REMARKS
820.4	QUARTZ DIORITE - HARD, MEDIUM GRAINED, WHITE AND BLACK	100% W.R. GRAY WHITE K 2.5
	JOINTS LIGHTLY WEATHERED	K 7.0
	JOINTS 1/2" BROWN CLAY SEAM, MOD WEATHERED, THIN FILM OF SILT	
		W.T. EL 805.4 K 27
	JOINTS, LIGHTLY WEATHERED	NO DRILL WATER RETURN
	JOINT, LIMONITE STAINING	K 2
786	ZONES OF LT WEA, RUST STAINING, RUST BROWN, OPEN JOINTS	K 10.5
777	MOD WEA, JOINTS, CHLORITE FILM, 1/8" BROWN ROTTEN ROCK	K 16
771	OPEN FRACTURING, LIGHTLY WEATHERED HIGH ANGLE	GROUND CORE K 16
		K 0
	JOINTS, SLIGHTLY WEATHERED	K 0
720.4		K 0

SNETTISHAM — SITE AND PROJECT | DH-53 — HOLE NO.

HOLE NO DH-54

SURFACE EL. 820.8 | N 103,270 | E 95,200

ELEVATIONS	DESCRIPTION OF MATERIALS	REMARKS
820	ROOTS AND SILT	
	QUARTZ DIORITE - HARD, MEDIUM GRAINED, MASSIVE, WHITE AND BLACK	100% WATER RETURN K 10
	JOINT (OPEN) 15°	K 17
		70% WATER RETURN K 0
	CLOSELY JOINTED ZONE 15° - 36°	K 1
	JOINT (STAINED) 23°	0% WATER RETURN K 0
771		4 BOXES OF CORE

SNETTISHAM DAM SITE — SITE AND PROJECT | DH-54 — HOLE NO.

HOLE NO DH-55

SURFACE EL. 813.3 | N 103,351 | E 95,165

ELEVATIONS	DESCRIPTION OF MATERIALS	REMARKS
	WATER - LONG LAKE	
776	BOTTOM OF LAKE	
	SILT, SAND, GRAVEL, COBBLES AND BOULDERS	NO SAMPLES SAVED
760	TOP OF ROCK	
	QUARTZ DIORITE - HARD TO MED HARD, MEDIUM GRAINED, MODERATELY WEATHERED, CLOSELY JOINTED, WHITE AND BLACK	100% WATER RETURN
	QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, MASSIVE, WHITE AND BLACK	K 0.065
737		3 BOXES OF CORE

SNETTISHAM (DAM SITE) — SITE AND PROJECT | DH-55 — HOLE NO.

HOLE NO DH-57

DEPTH OF HOLE 133.4 | OF OB 50.6 | DIAMETER OF HOLE NX
ROCK DRILLED 102.7 | % REC 95.0 | DATE STARTED 18 Sep 65
AZIMUTH HOLE | HADE 0 | DATE COMPLETED 24 Sep 65
INITIALS WBT | CONTRACT NO

SURFACE EL. 813.9 | N 103,414 | E 95,220

ELEVATIONS	DESCRIPTION OF MATERIALS	REMARKS
813.9	WATER, LONG LAKE	
763.7	SILT, SAND, GRAVEL, OCCASIONAL, COBBLES AND BOULDERS	

SNETTISHAM — SITE AND PROJECT | DH-57 — HOLE NO

HOLE NO DH-57

DEPTH OF HOLE 133.4 | OF OB 50.6 | DIAMETER OF HOLE NX
ROCK DRILLED 102.7 | % REC 95.0 | DATE STARTED 18 Sep 65
AZIMUTH HOLE | HADE 0 | DATE COMPLETED 24 Sep 65
INITIALS WBT | CONTRACT NO

SURFACE EL. 813.0 | N 103,414 | E 95,229

ELEVATIONS	DESCRIPTION OF MATERIALS	REMARKS
	QUARTZ DIORITE - HD, MED GR, WHITE & BLACK, LT WEA WITH CHLORITE COATING ON SOME JOINTS	
799	WEA, BROWN OXIDIZED, MOD SOFT	CORE LOSS DUE TO GRINDING
		100% W.R. FROM APPROX 120.0'
691	MOD WEA, RUST STAINED, CORE BADLY BROKEN	K 12
680.4	NOTE: TOTCO DEVIATION SURVEY INDICATED 2°-4° DEVIATION FROM VERTICAL AT 133.4	3 BOXES OF CORE

SNETTISHAM — SITE AND PROJECT | DH-57 — HOLE NO

HOLE NO DH-58

DEPTH OF HOLE 169.7 | OF OB 1.0 | DIAMETER OF HOLE NX
ROCK DRILLED 168.4 | % REC 99.2 | DATE STARTED 21 Sep 65
AZIMUTH HOLE | HADE vertical | DATE COMPLETED
INITIALS WCB | CONTRACT NO

SURFACE EL. 865.2 | N 103,135 | E 95,233

ELEVATIONS	DESCRIPTION OF MATERIALS	REMARKS
865.2	ORGANIC SANDY SILT, BROWN	
	QUARTZ DIORITE - HARD, MEDIUM GRAINED, WHITE & BLACK, WITH LOCAL VARIATIONS TO DIORITE, DENSE, DARK GRAY TO BLACK	
850	OPEN JOINT; WATER LOSS	K 44
	LIGHTLY WEATHERED JOINTS	K
	LIGHTLY WEATHERED JOINTS	K 1.3
	MOD WEATHERED JOINTS	
	LIGHTLY WEATHERED JOINTS	
	OPEN JOINTS; WATER LOSS	
	LIGHTLY WEATHERED JOINTS	
	MOD WEATHERED JOINT	
770	LIGHTLY WEATHERED JOINT	

SNETTISHAM — SITE AND PROJECT | DH-58 — HOLE NO

DEPTH OF HOLE 172.7 OF OB 2.7 DIAMETER OF HOLE NX
ROCK DRILLED 172.0 % REC 92.8 DATE STARTED 16 Sep 67
AZIMUTH HOLE HADE 0 DATE COMPLETED
INITIALS WRT CONTRACT NO

SURFACE EL. 849.7 HOLE NO DH-56 N 103,169 E 95,327

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
849.7				ORGANIC SANDY SILT	
				QUARTZ DIORITE - HARD, MEDIUM GRAINED, WHITE & BLACK, LIGHTLY WEATHERED, RUST STAINED JOINTS COMMON	K 46
	10			JOINT WITH 1/16" SOFT, RUST BROWN FILLING	LOST WATER AT 14.4; K 105+
	20				K 7.7
	30			JOINT, OPEN LT WEA	K 0
	40				
	50				K 20
	60			JOINT ZONE, LT WEA; JOINT, ½" SILT & SAND SIZE PARTICLES OF ROTTEN ROCK	K 6.8
	70				K 9
	80				K 4.9
	90				K 0
	100				K 0

SNETTISHAM
SITE AND PROJECT
DH-56
HOLE NO.

DEPTH OF HOLE 172.7 OF OB 0.7 DIAMETER OF HOLE NX
ROCK DRILLED 172.0 % REC 92.8 DATE STARTED 16 Sep 67
AZIMUTH HOLE HADE 0 DATE COMPLETED
INITIALS WRT CONTRACT NO

SURFACE EL. 849.7 HOLE NO DH-56 N 103,169 E 95,327

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
					10 11; K 0
	110				12; K 0
	120				12 13; K 0
718	130			JOINT, CHLORITE COATED	14; K 0
	140				
703				JOINT, CHLORITE FILM COATING	
699	150			CLOSE JOINTING, LT TO MOD WEA, ALONG JOINTS, WITH MINERALOID FILLING. ANGLES FROM 2° TO 80°	15; K 0.05
	160				16; K 0
680	170				
677	172				12 BOXES OF CORE

SNETTISHAM
SITE AND PROJECT
DH-56
HOLE NO.

DEPTH OF HOLE 162.2 OF OB 1.0 DIAMETER OF HOLE NX
ROCK DRILLED 160.2 % REC 94.2 DATE STARTED 21 Sep 67
AZIMUTH HOLE HADE vertical DATE COMPLETED 3 Oct 67
INITIALS MGB CONTRACT NO

SURFACE EL. 865.2 HOLE NO DH-58 N 103,135 E 95,233

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
	100			QUARTZ DIORITE AS ABOVE	9; K 0.11
758				DEEPLY WEATHERED JOINT	
	110				11; K 0.09
	120				12; K 0
	130				11 12
731				MODERATELY WEATHERED JOINT	K 0.06
	140				13 14; K 0
	150				15 16
715				MODERATELY WEATHERED JOINT	K 0
	160				15 16
				LIGHTLY WEATHERED	K 0
	162				16

SNETTISHAM
SITE AND PROJECT
DH-58
HOLE NO.

NOTE:
SEE LOG RECORD NUMBER 1 FOR NOTES AND LEGEND

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORDS NO. 13

SCALE
DATE 25 Oct 68
FILE NUMBER
SHEET OF

CORPS OF ENGINEERS

HOLE NO DH-59

DEPTH OF HOLE 90.1 — OF O.B. 0.8 — DIAMETER OF HOLE NX
ROCK DRILLED 89.3 — % REC 98.1 — DATE STARTED 2 Oct 65
AZIMUTH HOLE — HADE 0° — DATE COMPLETED 2 Oct 65
INITIALS WBT — CONTRACT NO.

SURFACE EL. 846.6 — N 103,212 — E 95,284

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		ORGANIC SILT, DARK BROWN	
		QUARTZ DIORITE - MD, MED TO COARSE GRAINED, WHITE & BLACK. LT WEA, WITH ZONES OF MOD WEA, RUST STAINED CLOSE JOINTING	K 8.7 K 22
828	20		LOST DRILL WATER AT ELEV 828'. CEMENTED THIS ZONE DUE TO VERY HEAVY CAVE IN LATER RUNS
825		BASALT DIKE, HARD, BROWN, DENSE WITH 0.3' ALTERATION ZONE AT BASE	K 9.1 K 0
		JOINT WITH 1" MOD SOFT, BLACK MICA SEAM	K 1.2 K 3
793		OPEN JOINT, 0.3', DIP 6° - 26°	VERY FAST PENETRATION K 46 K 0.03
		MOD TO MASSIVE JOINTING	K 0.07 K 0.05
	90		6 BOXES OF CORE

SNETTISHAM — SITE AND PROJECT — DH-59 — HOLE NO.

HOLE NO DH-60

DEPTH OF HOLE 121.2 — OF O.B. 0.0 — DIAMETER OF HOLE NX
ROCK DRILLED 20.0 — % REC 100 — DATE STARTED 1 Oct 65
AZIMUTH HOLE — HADE 0 — DATE COMPLETED 2 Oct 65
INITIALS WBT — CONTRACT NO.

SURFACE EL. 813.9 — N 103,337 — E 94,933

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		WATER, LONG LAKE	
720.7		QUARTZ DIORITE - MD, MED TO CRS GR, WHITE AND BLACK, MASSIVE JOINTING	TOP OF ROCK

SNETTISHAM — SITE AND PROJECT — DH-60 — HOLE NO.

HOLE NO DH-60 (continued)

DEPTH OF HOLE 121.2 — OF O.B. 0.0 — DIAMETER OF HOLE NX
ROCK DRILLED 20.0 — % REC 100 — DATE STARTED 1 Oct 65
AZIMUTH HOLE — HADE 0° — DATE COMPLETED 2 Oct 65
INITIALS WBT — CONTRACT NO.

SURFACE EL. 813.9 — N 103,337 — E 94,933

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		QUARTZ DIORITE, AS ABOVE	
690.7	123		2 BOXES OF CORE

SNETTISHAM — SITE AND PROJECT — DH-60 — HOLE NO.

HOLE NO DH-63

DEPTH OF HOLE 80.0 — OF O.B. 0.0 — DIAMETER OF HOLE NX
ROCK DRILLED 80.0 — % REC 99.6 — DATE STARTED 3 Oct 65
AZIMUTH HOLE — HADE 0° — DATE COMPLETED 3 Oct 65
INITIALS WBT — CONTRACT NO.

SURFACE EL. 812 — N 103,402 — E 95,442

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		QUARTZ DIORITE - HARD, MEDIUM TO COARSE GRAINED, WHITE & BLACK, SLIGHT TO MOD WEA, RUST STAINING, OCCASIONAL CHLORITE FILM ON JOINTS. CLOSE TO MASSIVE JOINTING.	K 38 K 32 NO WATER RETURN K 59 K 9.1
774		DIORITE - MOD HARD, FINE TO MEDIUM GRAINED, GRAY BLACK, MASSIVE JOINTING WITH OCCASIONAL QUARTZ SEAMS	K 0 K 0
		0.2 QUARTZ SEAM	K 0 K 0
732	80		6 CORE BOXES

SNETTISHAM — SITE AND PROJECT — DH-63 — HOLE NO.

HOLE NO DH-64

DEPTH OF HOLE 72.6 — OF O.B. 45.0 — DIAMETER OF HOLE NX
ROCK DRILLED 27.6 — % REC 100% — DATE STARTED 8 Oct 65
AZIMUTH HOLE — HADE 0° — DATE COMPLETED 11 Oct 65
INITIALS WBT — CONTRACT NO.

SURFACE EL. 822.2 — N 103,592 — E 95,445

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		SILTY SANDY GRAVEL, COBBLES COMMON OCCASIONAL BOULDERS UP TO 8.0'	
777.2		DIORITE - MOD HARD, MEDIUM TO COARSE GRAINED, BLACK & WHITE, MASSIVE, FRESH, QUARTZ SEAMS COMMON	TOP OF ROCK 100% DRILL WATER RETURN K 1.0
		QUARTZ DIORITE - HARD	
749.6	72.6		2 CORE BOXES OF CORE

SNETTISHAM — SITE AND PROJECT — DH-64 — HOLE NO.

HOLE NO DH-65

DEPTH OF HOLE 30.8 — OF O.B. 9.3 — DIAMETER OF HOLE NX
ROCK DRILLED 21.5 — % REC 98.8 — DATE STARTED 9 Oct 65
AZIMUTH HOLE — HADE 0° — DATE COMPLETED 10 Oct 65
INITIALS WBT — CONTRACT NO.

SURFACE EL. 1.4 — N 94,546 — E 92,896

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		SILT, ORGANIC, GRAY BLACK	
		SANDY GRAVEL, OCCASIONAL COBBLES AND BOULDERS	TOP OF ROCK
-7.9	10	QUARTZ DIORITE - HARD, MED GRAINED, WHITE AND BLACK, MASSIVE, LT WEA, RUST STAINED, OCCASIONAL CHLORITE FILM COVERED JOINTS	
-29.4	30		2 BOXES OF CORE

SNETTISHAM — SITE AND PROJECT — DH-65 — HOLE NO.

U. S. ARMY

DEPTH OF HOLE 91.2 OF OB 0.0 DIAMETER OF HOLE NX
ROCK DRILLED 91.2 % REC 99.0 DATE STARTED 30 Sep 65
AZIMUTH HOLE HADE DATE COMPLETED 1 Oct 65
INITIALS WEI CONTRACT NO

SURFACE EL 862 HOLE NO DH-61 N 103,132 E 95,283

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
		QUARTZ DIORITE - HARD, MED GRAINED, WHITE & BLACK, MASSIVE, LT WEA, JOINTING	K 12
	10		
		JOINTING, PARALLEL, WEATHERED RUST STAINING	K 100
	20		K 65
	30		K 65
825	40	OPEN FISSURE 0.2'	VERY FAST PENETRATION
		ZONE OF CLOSE JOINTING, LT TO MOD WEA, RUST STAINED	K 24
	50	JOINT, MOD WEA, BROKEN, 1/8" MED GRAINED, GRAY BROWN GRUS	K 26
	60		
		CLOSE JOINTING, LIGHT WEATHERING RUST STAINED 0° - 78° DIP	K 33
	70	BASALT DIKE, HARD, DENSE, VERY FINE GRAINED, BLACK, MOD WEA, RUST STAINED.	K 1
		ZONES OF MOD WEA, RUST STAINING & CHEMICAL ALTERATION DUE TO CONTACT METAMORPHISM BY BASALT DIKE	
	80		
777		BASALT DIKE, HARD, DENSE, APHANITIC, BLACK TO GREENISH BLACK WITH ZONE OF ALTERATION ON TOP & BOTTOM	K 29
771.8	90 / 91.2		
		NOTE: SURFACE ELEV APPROXIMATE	7 BOXES OF CORE

SNETTISHAM — SITE AND PROJECT — DH-61 HOLE NO.

DEPTH OF HOLE 95.5 OF OB 0.9 DIAMETER OF HOLE NX
ROCK DRILLED 94.6 % REC 99.6 DATE STARTED 3 Oct 65
AZIMUTH HOLE HADE vertical DATE COMPLETED 3 Oct 65
INITIALS WCB CONTRACT NO

SURFACE EL Approx 858 HOLE NO 62 N 103,174 E 95,258

ELEVATIONS	DEPTH	DESCRIPTION OF MATERIALS	REMARKS
858		ORGANIC SILT, DARK BROWN	
		QUARTZ DIORITE, HARD, MEDIUM GRAINED, BLACK & WHITE. LOCALLY VARIES TO DIORITE, DARK GRAY TO BLACK	K 0.0
		LIGHTLY WEATHERED JOINT	
	10		
843		LIGHTLY WEATHERED OPEN JOINTS	K 42
	20	LIGHTLY WEATHERED JOINTS	K 19
	30		
835		MODERATE WEATHERED JOINTS	
832		LIGHTLY WEATHERED JOINTS	K 4.4
	40		
	50	LIGHTLY WEATHERED JOINTS	K 35
	60		K 0.1
		LIGHTLY WEATHERED JOINTS	
787	70	MODERATELY WEATHERED JOINTS	K 0.0
		LIGHTLY WEATHERED JOINTS	
778	80	80.0' - 87.0', ZONE OF HIGH-ANGLE WEATHERED JOINTS.	K 0.55
	90		K 0.34
752	95.5		

SNETTISHAM — SITE AND PROJECT — DH-62 HOLE NO.

NOTE:
SEE LOG RECORD NUMBER 1 FOR NOTES AND LEGEND

REVISION | DATE | DESCRIPTION | BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: D.J. LAHNEL
DRAWN: D.J. LAHNEL
CHECKED: Wm. B. Tomtosia
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORD NO. 14

SUBMITTED: N. B. Dixon
SUBMITTED: Leland B. Yeaw — CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George — CHIEF, ENGINEERING DIVISION
APPROVED: Chas. J. Daley — COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 25 Oct 65
FILE NUMBER
SHEET OF

CORPS OF ENGINEERS

DEPTH OF HOLE [illegible] OF OB [illegible]	DIAMETER OF HOLE NX
ROCK DRILLED [illegible] % REC 100	DATE STARTED [illegible]
AZIMUTH HOLE 0 HADE 0	DATE COMPLETED [illegible]
INITIALS [illegible]	CONTRACT NO
SURFACE EL. 1.9 HOLE NO DH-67	N 94,499 E 92,826

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				SILT, GRAY BLACK, ORGANIC	
				SANDY GRAVEL, WITH COBBLES, BOULDERS AND FINE GRAINED SAND LENSES	TOP OF ROCK
-7.9				QUARTZ DIORITE - HARD, MED GRAINED WHITE & BLACK, CLOSE JOINTING, SLIGHT TO MODERATE WEA, WITH RUST STAINING & OCCASIONAL COATINGS OF CHLORITE ON JOINTS.	100% DRILL WATER RETURN
	20				
-20.0					1 BOX OF CORE

SHETTISHAN
SITE AND PROJECT

DH-67
HOLE NO.

NOTE:
SEE LOG RECORD NUMBER 1 FOR NOTES AND LEGEND

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: D.J. LAGREL
DRAWN: D.J. LAGREL
CHECKED: Wm. B. Terwthrin
PREPARED:
CHIEF,

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

LOG RECORD NO. 15

SUPERVISED: N.A. Dixon
CHIEF, GEOLOGY SECTION
SUBMITTED: [illegible]
CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George
CHIEF, ENGINEERING DIVISION

APPROVED: Clay F. Farley
COLONEL, CE, DISTRICT ENGINEER

SCALE
DATE 25 Oct 65
FILE NUMBER
SHEET OF

2

PART 8 LOG RECORDS AUGER HOLES

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 92,363 E 92,778
Drilling agency	Corps of Engineers
Hole No.	Field AH 1, Permanent AH 1
Name of driller	Benfield & Bellew
Weather	Rainy
Type of hole	Auger hole
Depth to	6.3
Total depth of hole	6.3
Size and type of bit	4" Hand Auger
Datum for elevation shown	MSL
Type of equipment	Hand Auger
Total no. of samples	2
Type of samples	Disturbed
Date hole started	8 Oct
Date hole completed	8 Oct
El. top of hole	-2.5
Geologist	JW Knox

Depth feet	Sample No.	Soil legend	Classification	Max size particle	Formation description & remarks
0	1	GM	Silty SAND F-2	6"	Glacial rock flour, marine deposition, dark grey, brown, green, blue tinges, some black organic streaks, occasional widely scattered pebbles and cobbles
5	2		Sandy SILT		Dark gray, sand very fine, quick, rounded grains, alluvial loose, saturated, sensitive.
6.3					

PROJECT Snettisham PERMANENT HOLE NO AH 1

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 91,877 E 92,650
Drilling agency	Corps of Engineers
Hole No.	Field AH 2, Permanent AH 2
Name of driller	Benfield & Bellew
Weather	Rainy
Depth to	3.0
Total depth of hole	3.0
Size and type of bit	4" Hand Auger
Datum for elevation shown	MSL
Type of equipment	Hand Auger
Total no. of samples	1
Type of samples	Disturbed
Date hole started	8 Oct
Date hole completed	8 Oct
El. top of hole	-1.2
Geologist	JW Knox

Depth feet	Sample No.	Soil legend	Classification	Formation description & remarks
0	1	SP-SM	Silty SAND F-2	Rounded to subangular grains, alluvial, loose, saturated, dark gray.
3				

NOTE: 1. Could not penetrate below 3.0' with auger due to flowage into hole.

PROJECT Snettisham PERMANENT HOLE NO AH 2

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 2
Location	N 91,670 E 92,520
Drilling agency	Corps of Engineers
Hole No.	Field AH 3, Permanent AH 3
Name of driller	Benfield
Weather	Rainy
Type of hole	Auger hole
Total depth of hole	12.6
Size and type of bit	4" Hand Auger
Datum for elevation shown	MSL
Type of equipment	Hand Auger
Total no. of samples	1
Type of samples	Disturbed
Date hole started	8 Oct
Date hole completed	8 Oct
Geologist	JW Knox

Depth feet	Sample No.	Soil legend	Classification	Formation description & remarks
0	1	ML	Sandy SILT F-4	Dark gray green, blue and brown tinges, black organic streaks, occasional widely scattered pebbles & cobbles, glacial rock flour, marine deposition.

PROJECT Snettisham PERMANENT HOLE NO AH 3

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	2 of 2
Location	N 92,049 E 92,726
Drilling agency	Corps of Engineers
Hole No.	Field AH 4, Permanent AH 4
Name of driller	Bellew & Benfield
Weather	Rainy
Type of hole	Auger hole
Total depth of hole	13.8
Size and type of bit	4" Hand Auger
Datum for elevation shown	MSL
Type of equipment	Hand Auger
Total no. of samples	2
Type of samples	Disturbed
Date hole started	8 Oct
Date hole completed	8 Oct
El. top of hole	+2.1
Geologist	JW Knox

Depth feet	Sample No.	Soil legend	Classification	Formation description & remarks
7.0	1	ML	Sandy SILT	
11.0			Silty SAND	Gray, fine, rounded, very fine fluid or sensitive.
13.8				

PROJECT Snettisham PERMANENT HOLE NO AH 4

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 94,340 E 94,618
Drilling agency	Corps of Engineers
Hole No.	Field AH 5, Permanent AH 5
Name of driller	Bellew & Benfield
Weather	Rainy
Type of hole	Auger hole
Total depth of hole	5.0
Size and type of bit	4" Hand Auger
Datum for elevation shown	MSL
Type of equipment	Hand auger
Total no. of samples	0
Date hole started	8 Oct
Date hole completed	8 Oct
El. top of hole	21.3
Geologist	JW Knox

Depth feet	Sample No.	Classification	Formation description & remarks
0	0	PEAT	Muskeg, water saturated, brown organic, considerable rotten wood and roots
4.5		Gravelly Silty SAND	With cobbles, some organic matter
5.0			

PROJECT Snettisham PERMANENT HOLE NO AH 5

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 94,623 E 94,668
Drilling agency	Corps of Engineers
Hole No.	Field AH 6, Permanent AH6
Name of driller	Bellew & Benfield
Weather	Rainy
Type of hole	Auger hole
Total depth of hole	6.1
Size and type of bit	4" Hand Auger
Datum for elevation shown	MSL
Type of equipment	Hand Auger
Total no. of samples	0
Date hole started	8 Oct
Date hole completed	8 Oct
El. top of hole	21.1
Geologist	JW Knox

Depth feet	Sample No.	Classification	Formation description & remarks
0	0	PEAT	Muskeg, water saturated, brown organic, considerable rotten wood
5.5	0	Gravelly Silty SAND	Occasional cobbles, much organic material dominating sample.
6.1			

PROJECT Snettisham PERMANENT HOLE NO AH 6

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	2 of 2
Location	N 91,670 E 92,520
Drilling agency	Corps of Engineers
Hole No.	Field AH 3; Permanent AH 3
Name of driller	Bendfield
Weather	Rainy
Type of hole	Auger hole
Total depth of hole	12.6
Size and type of bit	Hand Auger
Datum for elevation shown	MSL
Type of equipment	Hand Auger
Type of samples	Disturbed
Date hole started	8 Oct
Date hole completed	8 Oct
Geologist	JW Knox

Classification	Formation Description & Remarks
Sandy SILT	

NOTE: 1. Location approximate, no survey control
2. Hole stopped because of broken auger
3. Water level varies with tide

PROJECT Snettisham PERMANENT HOLE NO. AH 3

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 2
Location	N 92,049 E 92,726
Drilling agency	Corps of Engineers
Hole No.	Field AH 4; Permanent AH 4
Name of driller	Bellew & Benfeld
Weather	Rainy
Type of hole	Auger hole
Total depth of hole	13.8
Size and type of bit	4" Hand Auger
Datum for elevation shown	MSL
Type of equipment	Hand Auger
Total no. of samples	2
Type of samples	Disturbed
Date hole started	8 Oct
Date hole completed	8 Oct
El. top of hole	+ 2.1
Geologist	JW Knox

Depth Feet	% Water Content	Sample No	Soil Legend	Classification	Max Size Particle	Formation Description & Remarks
				SILT		Organic, black, high ca
1.0				Sandy SILT		Dark blue to grennish gray, glacial rock flour, marine deposition, occasional widely scattered pebbles and cobbles
		1	ML	F-4	6"	
2.0						
3.0						
4.0						
5.0						
6.0						
7.0						

NPA FORM 19 (REV) DEC 1959

PROJECT Snettisham PERMANENT HOLE NO. AH 4

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	1 of 1
Location	N 94,487 E 94,809
Drilling agency	Corps of Engineers
Hole No.	Permanent AH 7A
Name of driller	Bellew & Bendfield
Weather	Rainy
Type of hole	Auger hole
Total depth of hole	3.4
Size and type of bit	Hand Auger
Datum for elevation shown	MSL
Type of equipment	Hand Auger
Date hole started	8 Oct
Date hole completed	8 Oct
Geologist	JW Knox

Classification	Formation Description & Remarks
PEAT	Muskeg, brown organic, water saturated, considerable rotten wood.

PROJECT Snettisham PERMANENT HOLE NO. AH 7A

Revision	Date	Description	By

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm B. Trautwein	SNETTISHAM PROJECT, ALASKA
DRAWN: Wm B. Trautwein	FIRST STAGE DEVELOPMENT
CHECKED: D J Lamel	AUGER HOLE LOG
PREPARED:	LOG RECORD NO. 1
SUPERVISED: M A Dixon, CHIEF, GEOLOGY SECTION	APPROVED: Clarence I. Farley, COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: Leland H. Jones, CHIEF, FOUND. & MAT'LS BRANCH	SCALE / DATE 20 Oct 61
RECOMMENDED: Warren George, CHIEF, ENGINEERING DIVISION	FILE NUMBER / SHEET OF

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham
Hole No.: AH 7B — Permanent: AH 7B
Name of driller: Bellew & Benfield — Weather: Rainy
Total depth of hole: 4.5
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: 0
Started: 8 Oct — Completed: 8 Oct
El. top of hole: 26.7 — Logger: JW Knox

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
				PEAT	Muskeg, brown, organic, water saturated, considerable rotted wood
1.0		0			
4.5					

PROJECT Snettisham — PERMANENT HOLE NO. AH 7B

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham
Hole No.: AH 7C — Permanent: AH 7C
Name of driller: Bellew & Benfield — Weather: Rainy
Size and type of bit: 4" Hand Auger — Type of equipment: Hand Auger
Started: 8 Oct — Completed: 8 Oct
Logger: JW Knox

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
				PEAT	Muskeg, brown, organic, water saturated, considerable rotted wood
2.0		0			

PROJECT Snettisham — PERMANENT HOLE NO. AH 7C

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham
Name of driller: Bellew & Benfield — Weather: Rainy
Total depth of hole: 1.4
Started: 8 Oct — Completed: 8 Oct
Logger: JW Knox

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
				PEAT	Muskeg, brown, organic, water saturated, considerable organic silt, some clay
1.0		0			
1.4					

PROJECT Snettisham — PERMANENT HOLE NO. AH 8A

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham
Location: N 94,904 — E 94,278
Drilling agency: Corps of Engineers
Hole No.: AH 10A & B — Permanent: AH 10A & B
Name of driller: Benfield — Weather: Rainy
Total depth of hole: 1.6
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: 0
Started: 8 Oct — Completed: 8 Oct
El. top of hole: 116.1 — Logger: JW Knox

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
				Organic SILT	Black, lean, some pebbles and coarse angular sand
1.0		0			
				Gravelly	
1.6					
		Top		AH 10A	
0				Organic SILT	Black, some small pebbles and coarse sand
		0			
1.0					
1.2					

PROJECT Snettisham — PERMANENT HOLE NO. AH 10A & B

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 88,119 — E 92,220
Drilling agency: Corps of Engineers
Hole No.: AH 11 — Permanent: AH 11
Name of driller: Benfeld Bellew — Weather: Rains
Total depth of hole: 2.4
Size and type of bit: 4" Auger — Type of equipment: Hand auger
Total no. of samples: 0 — Depth to ground water: 1.0
Started: 9 Oct — Completed: 9 Oct
El. top of hole: -2.5 — Logger: J. W. Knox

Depth feet	Water content	Sample no.	Soil legend	Classification	Max. size particle	Formation description & remarks
				Gravelly, SILT	1.0"	Gray, marine. (Glacial rock flour origin)
1		0				
				SILT	6"	Considerable subangular gravel, marine deposition.
2						Cobble or boulder

NOTES: 1. Water table varies with tides.
2. Gravel is progressively coarser inland, grading into landslide debris from slopes to south.

PROJECT Snettisham — PERMANENT HOLE NO. AH 11

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham
Location: N 88310 — E 92180
Drilling agency: Corps of Engineers
Hole No.: AH 12 — Permanent: AH 12
Name of driller: Bendfeld, Bellew — Weather: Rainy
Total depth of hole: 13.0
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: 1 — Type of samples: distutbed
Started: 9 Oct — Completed: 9 Oct
Logger: J. W. Knox

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
				SILT	Marine, bluish gray, sea shells common.
1			ML	[illegible]	
2					
3		0			
4					
5					
6		1			

PROJECT Snettisham — PERMANENT HOLE NO. AH 12

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 94635 E 94630
Drilling agency: Corps of Engineers
Permanent hole no.: AH 88
Name of driller: Bellew & Benfield — Weather: Rainy
Type of hole: Auger hole
Total depth of hole: 3.4
Type of equipment: Hand Auger
Type of samples: Disturbed
Date hole started: 8 Oct — Completed: 8 Oct
Knox

Sample No.	Soil legend	Classification	Formation description & remarks
0		PEAT	Muskeg, brown, organic, saturated, considerable organic silt, some clay
1	SP	Gravelly SAND NFS	Fine subrounded pea gravel and coarse sand, some silty fines

PROJECT Snettisham — PERMANENT HOLE NO. AH 88

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 94,745 E 94,502
Drilling agency: Corps of Engineers
Field hole no.: AH 9 — Permanent: AH 9
Name of driller: Bellew & Benfield — Weather: Rainy
Type of hole: Auger hole
Total depth of hole: 2.5
Size and type of bit: 4" Auger
Datum for elevation shown: MSL
Type of equipment: Hand Auger
Total no. of samples: 0
Date hole started: 8 Oct — Completed: 8 Oct
El. top of hole: 83.6 — Geologist: JW Knox

Depth feet	Sample No.	Classification	Formation description & remarks
1.0	0	Organic SILT	Gradually sandier with depth.
2.0		Silty SAND	Some clay fines.
2.5			

PROJECT Snettisham — PERMANENT HOLE NO. AH 9

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham
Location: N 88310 E 92120
Drilling agency: Corps of Engineers
Permanent hole no.: AH 12
Name of driller: Benfeld, Bellew — Weather: Rainy
Type of hole: Auger hole
Total depth of hole: 13.0
Type of equipment: Hand Auger
Type of samples: Disturbed
Date hole started: 9 Oct — Completed: 9 Oct
Geologist: J. W. Knox

Classification	Formation description & remarks
SILT	Heavy, squeezing ground, silt flowing into hole.

NOTES: 1. Location approximate, no survey control.

PROJECT Snettisham — PERMANENT HOLE NO. AH 12

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm Trautwein
DRAWN: Wm Trautwein
CHECKED: D. Hanson
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
AUGER HOLE LOG
LOG RECORD NO. 2

SUPERVISED: N. A. Dixon — CHIEF, GEOLOGY SECTION
APPROVED: Clare I. Farley — COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: [signature] — CHIEF, FOUNDATIONS & MATERIALS BRANCH
SCALE — DATE 20 Oct 65
RECOMMENDED: [signature] — CHIEF, ENGINEERING DIVISION
FILE NUMBER
SHEET OF

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
N 87470 E 92,740
Hole No.: Field AH 13, Permanent AH 13
Driller: Benfeld, Bellow — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 5.4'
Size and type of bit: 4" auger — Type of equipment: Hand auger
Total no. of samples: 0
Started: 9 Oct — Completed: 9 Oct
Geologist: J. W. Knox

Depth (feet)	Sample no.	Classification	Formation description & remarks
		SILT	Dark, blue gray, marine deposited, glacial flour with angular cobbles and boulders increasing towards shore.
1			
2	0		
3			
4			
5			

NOTES: 1. Location approximate, no survey control.
2. Area under water at high tide.

Project: Snettisham — Permanent hole no.: AH 13

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
N 87840 E 92550
Hole No.: Field AH 14, Permanent AH 14
Driller: Benfeld — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 2.3
Size and type of bit: 4" auger — Type of equipment: Hand auger
Total no. of samples: 0
Started: 9 Oct — Completed: 9 Oct
Geologist: J. W. Knox

Depth (feet)	Sample no.	Classification	Formation description & remarks
		SILT	Dark, blue gray, marine. Cobbles and boulders approx. 100' SW of hole.
1	0		
2			Stopped by boulder

NOTES: 1. Location approximate, no survey control.
2. Under water at high tide.

Project: Snettisham — Permanent hole no.: AH 14

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 2
N 88,529 E 92,083
Hole No.: Field AH 15, Permanent AH 15
Driller: Benfeld — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 13.0
Size and type of bit: 6" auger — Type of equipment: Hand auger
Total no. of samples: 1 — Type of samples: Disturbed
Depth to ground water: 4.0
Started: 9 Oct — Completed: 9 Oct
Elevation top of hole: -1.0 — Geologist: J. W. Knox

Depth (feet)	Sample no.	Classification	Formation description & remarks
		SILT	Dark, blue gray, marine estuarine, small shells common plastic.
1	1		
2			
3			
4			Water table 4.0' deep when augered.
5			
6			
7			

Project: Snettisham — Permanent hole no.: AH 15

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 2 of 2
N 88680 E 91830
Hole No.: Field AH 16, Permanent AH 16
Driller: Benfeld — Weather: Rainy
Total depth of hole: 13.0'
Size and type of bit: 6" auger — Type of equipment: Hand auger
Total no. of samples: 0
Started: 9 Oct — Completed: 9 Oct
Geologist: J. W. Knox

Depth (feet)	Sample no.	Classification	Formation description & remarks
		SILT	Squeezing ground, depth of hole limited as hole fills up slowly thru flowage of silt.
8	0		
9			
10			
11			
12			
13			

NOTES: 1. Location approximate, no survey control.
2. Area under water at high tide.

Project: Snettisham — Permanent hole no.: AH 16

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
N 89,173 E 91,645
Hole No.: Field AH 17, Permanent AH 17
Driller: Benfeld
Total depth of hole: 2.0
Size and type of bit: 4" Auger — Type of equipment: Hand auger
Total no. of samples: 0
Started: 9 Oct — Completed: 9 Oct
Elevation top of hole: 1.4 — Geologist: J. W. Knox

Depth (feet)	Sample no.	Classification	Formation description & remarks
		SILT	Black, organic.
1.0	0	SILT	Dark blue gray, marine
2.0			Stopped by boulder

NOTES: 1. No water table reached.
2. Boulders and cobbles with interstitial silts and sand exposed in nearby stream cut.

Project: Snettisham — Permanent hole no.: AH 17

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 2
N 92,590 E 92,740
Hole No.: Field AH 18, Permanent AH 18
Driller: Benfeld & Bellow — Weather: Rainy
Total depth of hole: 13.0
Size and type of bit: 6" Auger — Type of equipment: Hand Auger
Total no. of samples: 0
Started: 9 Oct — Completed: 9 Oct
Geologist: JW Knox

Depth (feet)	Sample no.	Classification	Formation description & remarks
		Sandy SILT	Dark blue gray, estuarine deposition, plastic, sensitive
1.0			
2.0	0		
3.0			
4.0			
5.0			
6.0			
7.0			

Project: Snettisham — Permanent hole no.: AH 18

DEPARTMENT ... NORTH ... U.S. ARMY ... EXPLORATION ...
Field AH 15 ... 4" auger ... -1.0

Depth (feet)	Sample no.
8	1
9	
10	
11	
12	
13	

DEPARTMENT ... NORTH PACIFIC ... U.S. ARMY ENGINEER ... EXPLORATION ...
Field AH 16 ... 4" Auger ... 0 ... JW Knox

Depth (feet)	Sample no.
8.0	
9.0	0
10.0	
11.0	
12.0	
13.0	

... OF THE ARMY / ...CIFIC DIVISION / ...ER DISTRICT, ALASKA / ... LOG

PROJECT	Snettisham
SHEET	2 OF 2
LOCATION (Coordinates or Station)	N 88,529 E 92,083
DRILLING AGENCY	CORPS OF ENGINEERS
NAME OF DRILLER	Benfeld
HELPER	Rainy
HOLE NO. PERMANENT	AH 15
TOTAL DEPTH OF HOLE	13.0
TYPE OF EQUIPMENT	Hand Auger
TYPE OF SAMPLES	Disturbed
DEPTH TO GROUND-WATER	4.0
DATE HOLE STARTED	9 Oct
DATE HOLE COMPLETED	9 Oct
	J. W. Knox

CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
SILT	Plasticity or flowage of clay and squeezing in of hole increases with depth.

NOTE: 1. Classified in field, no laboratory test at this time.
2. Under water at high tide.

PROJECT Snettisham PERMANENT HOLE NO. AH 15

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 2
LOCATION (Coordinates or Station)	N 88870 E 91830
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO. FIELD	AH 16
PERMANENT	AH 16
NAME OF DRILLER	Benfeld
HELPER	Rainy
TYPE OF HOLE	AUGER HOLE
TOTAL DEPTH OF HOLE	13.0
SIZE AND TYPE OF BIT	4" auger
TYPE OF EQUIPMENT	Hand auger
TOTAL NO. OF SAMPLES	0
DATE HOLE STARTED	9 Oct 64
COMPLETED	9 Oct
	J. W. Knox

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
0–4	0	SILT	Dark blue gray, estuarine deposition, probable glacial flour in origin.
4–7	0	SILT	Dark blue to greenish gray, marine deposition.

NPA FORM 1 DEC 1959 ... (REV)

PROJECT Snettisham PERMANENT HOLE NO. AH 16

... THE ARMY / ...C DIVISION / ... DISTRICT, ALASKA / ... LOG

PROJECT	Snettisham
SHEET	2 OF 2
LOCATION (Coordinates or Station)	N 92,590 E 92,740
DRILLING AGENCY	CORPS OF ENGINEERS
PERMANENT	AH 18
NAME OF DRILLER	Benfield & Belley
HELPER	Rainy
TOTAL DEPTH OF HOLE	13.0
TYPE OF EQUIPMENT	Hand Auger
DATE HOLE STARTED	9 Oct
COMPLETED	9 Oct

CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
Sandy SILT	

PROJECT Snettisham PERMANENT HOLE NO. AH 18

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm. A. Trautwein
DRAWN: Wm. A. Trautwein
CHECKED: D. J. Linker
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
AUGER HOLE LOG
LOG RECORD NO. 3

SUPERVISED: N. A. Dixon CHIEF, GEOLOGY SECTION
SUBMITTED: CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Francis George CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Field	
Project	Snettisham
Sheet	1 of 1
Location	N 95,292 E 94,408
Drilling agency	Corps of Engineers
Hole no.	Field AH 26, Permanent AH 26
Name of driller	Imlach & Klicker
Weather	Rainy
Total depth of hole	3.6
Size and type of bit	4" Auger
Type of equipment	Hand Auger
Total no. of samples	0
Started	10 Oct
Date hole completed	10 Oct
El. top of hole	106.8
Geologist	JW Knox

Depth feet	Sample no.	Classification	Max size particle	Formation description & remarks
		SILT		Organic, peaty, muskeg origin, brown and black.
2.0	0			
3.0		Sandy SILT		Coarse
3.6				Boulder

PROJECT Snettisham PERMANENT HOLE NO AH 26

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Field	
Project	Snettisham
Sheet	1 of 1
Location	N 95,348 E 94,265
Drilling agency	Corps of Engineers
Hole no.	Field AH 27, Permanent AH 27
Name of driller	Imlach & Klicker
Weather	Rainy
Total depth of hole	2.0
Size and type of bit	4" Auger
Type of equipment	Hand Auger
Total no. of samples	0
Started	10 Oct
Date hole completed	10 Oct
El. top of hole	122.2
Geologist	JW Knox

Depth feet	Sample no.	Classification	Max size particle	Formation description & remarks
		SILT		Organic, peaty, brown to black, muskeg origin.
1.0	0			
		Silty SAND	3"	Coarse, angular.
2.0				Boulder

PROJECT Snettisham PERMANENT HOLE NO AH 27

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Field	
Project	Snettisham
Sheet	1 of 1
Location	N 94,958 E 94,165
Drilling agency	Corps of Engineers
Hole no.	Field AH 28, Permanent AH 28
Name of driller	Imlach & Klicker
Weather	Rainy
Total depth of hole	2.2
Size and type of bit	4" Auger
Type of equipment	Hand Auger
Total no. of samples	0
Started	10 Oct
Date hole completed	10 Oct
El. top of hole	125.7
Geologist	JW Knox

Depth feet	Sample no.	Classification	Max size particle	Formation description & remarks
		SILT		Organic, peaty, muskeg origin saturated.
1.0	0			
		Silty SAND		Some pebbles, angular to subrounded particles.
2.0				
2.2				

PROJECT Snettisham PERMANENT HOLE NO AH 28

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Field	
Project	Snettisham
Sheet	1 of 1
Location	N 91860 E 90640
Drilling agency	Corps of Engineers
Hole no.	Field AH 31, Permanent AH 31
Name of driller	Klicker
Weather	Rainy
Total depth of hole	3.9
Size and type of bit	4" auger
Type of equipment	Hand auger
Total no. of samples	1
Type of samples	Disturbed
Started	12 Oct
Date hole completed	12 Oct
Geologist	J. W. Knox

Depth feet	Sample no.	Classification	Max size particle	Formation description & remarks
	0	SILT,		Organic estuarine, dark blackish gray, lean
1		Gravelly Sandy SILT		Dark gray, occasional cobbles.
2				
3	1			
3.9				

NOTES:
1. Location approximate, no survey control.
2. Classified in field, no laboratory test at this time.
3. Boulder to 2.0' size, exposed in bed of nearby stream.

PROJECT Snettisham PERMANENT HOLE NO AH 31

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Field	
Project	Snettisham
Sheet	1 of 1
Location	N 91620 E 90460
Drilling agency	Corps of Engineers
Hole no.	Field AH 32, Permanent AH 32
Name of driller	Klicker
Weather	Rainy
Total depth of hole	4.5
Size and type of bit	4" Auger
Type of equipment	Hand Auger
Total no. of samples	0
Depth to ground water	1.0
Started	12 Oct
Date hole completed	12 Oct
Geologist	J. W. Knox

Depth feet	Sample no.	Classification	Max size particle	Formation description & remarks
		SILT		Dark blue gray, estuanne origin possibly glacial flour, organic near surface.
1		WT 1.0'		
2	0			
3				
4				
4.5				

NOTE:
1. Location approximate, no survey control.
2. Water level varies with tides.

PROJECT Snettisham PERMANENT HOLE NO AH 32

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Field	
Project	Snettisham
Sheet	1 of 1
Location	N 91350 E 90350
Drilling agency	Corps of Engineers
Hole no.	Field AH 33, Permanent AH 33
Name of driller	Klicker
Weather	Rainy
Total depth of hole	3.0
Size and type of bit	4" Auger
Type of equipment	Hand Auger
Total no. of samples	1
Type of samples	Disturbed
Started	12 Oct
Date hole completed	12 Oct
Geologist	J. W. Knox

Depth feet	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
			SILT		Dark blue gray, estuarine origin, organic near surface lean.
1	0				
2			Silty Sandy GRAVEL	6"	Subrounded, gray fines.
	1	GP-GM	F-1		
3					Stopped by cobble

NOTES: 1. Location approximate, no survey control.

PROJECT Snettisham PERMANENT HOLE NO AH 33

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 94,232 E 22,976
Drilling agency: Corps of Engineers
Hole No.: Permanent AH 29
Name of driller: Imalch & Klicker — Weather: Rainy
Type of hole: Auger hole
Total depth of hole: 2.8
Datum for elevation shown: MSL
Type of equipment: Hand Auger
Date hole started: 10 Oct — Completed: 10 Oct
Geologist: JW Knox

Sample No.	Classification	Formation Description & Remarks
0	SILT	Organic, peaty, brown to black muskeg origin.
	Silty SAND	Some pebbles, angular

PROJECT Snettisham — PERMANENT HOLE NO. AH 29

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 91,871 E 90,822
Drilling agency: Corps of Engineers
Hole No.: Field AH 30 — Permanent AH 30
Name of driller: Caskey & Klicker — Weather: Rainy
Type of hole: Auger hole
Total depth of hole: 2.5
Size and type of bit: 4" Auger
Datum for elevation shown: MSL
Type of equipment: Hand Auger
Total no. of samples: 0
Date hole started: 10 Oct — Completed: 10 Oct
El. top of hole: 5.8 — Geologist: JW Knox

Depth Feet	Sample No.	Classification	Formation Description & Remarks
		Organic SILT	Blue gray, organic near surface, estuarine origin.
1.0	0		
2.0		GRAVEL	Coarse cobbles & boulders, interstial silt.
2.5			Stopped by 6" Cobble

PROJECT Snettisham — PERMANENT HOLE NO. AH 30

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 90,998 E 90,561
Drilling agency: Corps of Engineers
Hole No.: Permanent AH 34
Name of driller: Caskey & Klicker — Weather: Rainy
Type of hole: Auger hole
Total depth of hole: 1.1
Type of equipment: Hand Auger
Type of samples: Disturbed
Date hole started: 12 Oct — Completed: 12 Oct
Geologist: JW Knox

Sample No.	Soil Legend	Classification	Formation Description & Remarks
0		SILT	Dark gray, some organic
1	GP	Sandy GRAVEL NFS	Red brown, rust stained
			Tightly packed cobbles.

PROJECT Snettisham — PERMANENT HOLE NO. AH 34

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE ALASKA

DESIGNED: Wm Trautwein
DRAWN: Wm Trautwein
CHECKED: [illegible]
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
AUGER HOLE LOG
LOG RECORD NO. 4

SUPERVISED: R. E. Dixon — CHIEF, GEOLOGY SECTION
APPROVED: [illegible] — COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: Roland B. [illegible] — CHIEF, FOUNDATIONS & MATERIALS BRANCH
SCALE — DATE 20 Oct 65
RECOMMENDED: [illegible] — CHIEF, ENGINEERING DIVISION
FILE NUMBER
SHEET OF

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 2
Location: N 92,820 E 92,580 — Drilling agency: Corps of Engineers
Hole No.: Field AH 19, Permanent AH 19
Name of driller: Gushulak & Perley — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 13.0
Size and type of bit: 4" Auger — Type of equipment: Hand auger
Total no. of samples: 0 — Date hole started: 10 Oct, completed: 10 Oct
Geologist: JW Knox

Depth feet	Water content	Sample no	Soil legend	Classification	Formation description & remarks
				Sandy SILT	Dark blue gray
1.0					
		0			
2.0					
3.0					
4.0					
5.0					
6.0					
7.0					

Project: Snettisham — Permanent hole no. AH 19

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 2 of 2
Location: N 92,820 E 92,580 — Drilling agency: Corps of Engineers
Hole No.: Field AH 19, Permanent AH 19
Name of driller: Gushulak & Perley — Weather: Rainy
Total depth of hole: 13.0

Depth feet	Water content	Sample no	Soil legend	Classification	Formation description & remarks
				Sandy SILT	Increasingly plastic and fluid with depth
8.0					
9.0					
10.0					
11.0					
12.0					
13.0				NOTE: 1. Location approximate, no survey control	

Project: Snettisham — Permanent hole no. AH 19

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 2
Location: N 93360 E 92110 — Drilling agency: Corps of Engineers
Hole No.: Field AH 20, Permanent AH 20
Name of driller: Perley and Gushulak — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 13.0
Size and type of bit: 4" auger — Type of equipment: Hand auger
Total no. of samples: 1 — Type of samples: Disturbed — Started: 10 Oct, completed: 10 Oct
Geologist: J. W. Knox

Depth feet	Water content	Sample no	Soil legend	Classification	Formation description & remarks
				SILT	Dark blue gray, upper 1.0' Some organic matter, estuarine Deposition.
1		1	ML	F-4	
2					Ground increasingly plastic and fluid with depth.
3					
4					
5					
6					
7					

Project: Snettisham — Permanent hole no. AH 20

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 92990 E 92450 — Drilling agency: Corps of Engineers
Hole No.: Field AH 22, Permanent AH 22
Name of driller: Perley and Gushulak — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 7.0
Size and type of bit: 4" auger — Type of equipment: Hand auger
Total no. of samples: 1 — Type of samples: Disturbed — Started: 10 Oct, completed: 10 Oct
Geologist: J. W. Knox

Depth feet	Water content	Sample no	Soil legend	Classification	Formation description & remarks
				Sandy SILT	Dark blue gray, estuarine origin, probable chiefly glacial rock flour, plastic
1			ML	F-4	
		1			
2					
3					
4					Sides squeezing in with depth.
5					
6				Notes: 1. Location approximate, no survey control.	
7					

Project: Snettisham — Permanent hole no. AH 22

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 94,720 E 94,676 — Drilling agency: Corps of Engineers
Hole No.: Field AH 23, Permanent AH 23
Name of driller: Imlach Klicker — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 3.4
Size and type of bit: 3 4" Auger — Datum: MSL — Type of equipment: Hand Auger
Total no. of samples: 0 — Started: 10 Oct, completed: 10 Oct
El. top of hole: 83.9 — Geologist: JW Knox

Depth feet	Water content	Sample no	Soil legend	Classification	Formation description & remarks
				SILT	Organic, muskeg origin, black to brown
1.0					
2.0		0			
3.0				Gravelly SILT	Brown
3.4					Boulder

Project: Snettisham — Permanent hole no. AH 23

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 95,065 E 94,506 — Drilling agency: Corps of Engineers
Hole No.: Field AH 24, Permanent AH 24
Name of driller: Imlach & Klicker — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 2.9
Size and type of bit: 4" Auger — Datum: MSL — Type of equipment: Hand Auger
Total no. of samples: 0 — Started: 10 Oct, completed: 10 Oct
El. top of hole: 86.4 — Geologist: JW Knox

Depth feet	Water content	Sample no	Soil legend	Classification	Formation description & remarks
				Sandy SILT	Organic, brown
1.0					
		0			
2.0					
2.9					Boulders

Project: Snettisham — Permanent hole no. AH 24

EPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	2 OF 2
LOCATION (Coordinates or Station)	N E
DRILLING AGENCY	Corps of Engineers
HOLE NO.	AH 20 PERMANENT AH 20
NAME OF DRILLER	Perley and Gushulak
WEATHER	Rainy
TYPE OF HOLE	Auger hole
TOTAL DEPTH OF HOLE	13.0
SIZE AND TYPE OF BIT	" auger
TYPE OF EQUIPMENT	Hand auger
NO. OF SAMPLES	1
TYPE OF SAMPLES	Disturbed
DATE HOLE STARTED	10 Oct
DATE HOLE COMPLETED	10 Oct
GEOLOGIST	J. W. Knox

% WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
			SILT		as above
	1	ML			

Note: 1. Location approximate, no survey control.

PROJECT Snettisham PERMANENT HOLE NO. AH 20

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U S ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
LOCATION (Coordinates or Station)	N 93,230 E 92,240
DRILLING AGENCY	Corps of Engineers
HOLE NO.	FIELD AH 21 PERMANENT AH 21
NAME OF DRILLER	Pesley & Gushulak
WEATHER	Rainy
TYPE OF HOLE	Auger hole
TOTAL DEPTH OF HOLE	6.0
SIZE AND TYPE OF BIT	4" Auger
TYPE OF EQUIPMENT	Hand Auger
TOTAL NO. OF SAMPLES	1
TYPE OF SAMPLES	Disturbed
DATE HOLE STARTED	10 Oct
DATE HOLE COMPLETED	10 Oct
GEOLOGIST	JW Knoe

DEPTH FEET	% WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				SILT		Dark blue gray, plastic, estuarine origin
1.0						
2.0		1				
3.0						
4.0						
5.0						
6.0						

NOTE: 1. Location Approximate, no survey control
2. Classified in field, no laboratory tests at this time.

NPA FORM 1959 (REV) DEC 1959

PROJECT Snettisham PERMANENT HOLE NO. AH 21

MENT OF THE ARMY
PACIFIC DIVISION
ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 1
LOCATION (Coordinates or Station)	N 95,100 E 94,445
DRILLING AGENCY	Corps of Engineers
HOLE NO.	PERMANENT AH 25
NAME OF DRILLER	Imlack & Klicker
WEATHER	Rainy
TYPE OF HOLE	Auger hole
TOTAL DEPTH OF HOLE	1.5
DATUM FOR ELEVATION SHOWN	MSL
TYPE OF EQUIPMENT	Hand Auger
DATE HOLE STARTED	10 Oct
DATE HOLE COMPLETED	10 Oct
GEOLOGIST	JW Knox

CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
Organic SILT		Black and Brown peaty, muskeg origin
Silty SAND		Coarse

NOTE: 1. Water hole 25 ft South of this hole 2.6' deep, contained 4-5" of coarse white gravelly sand, overlaying solid material.
Series of similar holes occur across terrace No2 near base of terrace No 3; Holes are up to 4.5' deep

PROJECT Snettisham PERMANENT HOLE NO. AH 25

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm B Trautwein
DRAWN: Wm B Trautwein
CHECKED: DW Lachel
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
AUGER HOLE LOG
LOG RECORD NO. 5

SUPERVISED: M A Dixon, CHIEF, GEOLOGY SECTION
SUBMITTED: CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George, CHIEF, ENGINEERING DIVISION
APPROVED: Clare F. Farley, COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 90,815 E 90,818 — Drilling agency: Corps of Engineers
Hole No.: Field AH 35, Permanent AH 35 — Name of driller: Caskey and Klicker — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 2.5
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: 0 — Started: 12 Oct — Completed: 12 Oct
El. top of hole: 7.6 — Geologist: J. W. Knox

Depth feet	Sample no.	Classification	Formation description & remarks
		SILT	Gray, probable glacial rock flour.
1	0		
2		Silty GRAVEL 6"	Subangular, some cobbles or boulders.
2.5			

PROJECT Snettisham — PERMANENT HOLE NO. AH 35

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 90,466 E 90,853 — Drilling agency: Corps of Engineers
Hole No.: Field AH 36, Permanent AH 36 — Name of driller: Caskey Klicker — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 1.5
Size and type of bit: 4" auger — Type of equipment: Hand Auger
Total no. of samples: 0 — Depth to ground water: 0.8 — Started: 12 Oct — Completed: 12 Oct
El. top of hole: 10.1 — Geologist: J. W. Knox

Depth feet	Sample no.	Classification	Formation description & remarks
		Silty SAND	Brown, near 8 foot diameter boulder.
	0	WT 0.8	
1		Silty GRAVEL	Cobbles common, marshy grass.
1.5			

NOTES: 1. Water level varied with tides.
2. 200 ft west, small stream cuts flats in 2.8' deep channel. Banks are clayey silt. Bottom of channel to 4.9' depth, coarse sand with some silty fines and pea size gravel. Below 4.9 cobbles.

PROJECT Snettisham — PERMANENT HOLE NO. AH 36

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Location: N 90,251 E 90,876 — Drilling agency: Corps of Engineers
Hole No.: Field AH 37, Permanent AH 37 — Name of driller: Caskey and Klicker — Weather: Rainy
Type of hole: Auger hole — Total depth of hole: 4.9
Size and type of bit: 4" auger — Type of equipment: Hand auger
Total no. of samples: 0 — Depth to ground water: 2.5' — Started: 12 Oct — Completed: 12 Oct
El. top of hole: 14.1 — Geologist: J. W. Knox

Depth feet	Sample no.	Classification	Formation description & remarks
		SILT	Some sand, well graded gray and brown, some organic material.
1	0		
2		Silty SAND	Gray subrounded, well graded.
		WT 2.5	
3	0		
4			
4.9	0	Cobbley Gravels	

NOTES: 1. Coarse cobbley, well graded, rounded to subrounded gravels exposed in Star Creek channel to NE of hole.

PROJECT Snettisham — PERMANENT HOLE NO. AH 37

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 91,800 E 92,576 — Drilling agency: Corps of Engineers
Hole No.: Field AH-40, Permanent AH-40 — Name of driller: O'Brien & Richmond — Weather: Fair
Type of hole: Auger hole — Total depth of hole: 6.6'
Size and type of bit: 4" Auger
Total no. of samples: 2 — Type of samples: Disturbed — Depth to ground water: 0 — Started: 29 Jun 65 — Completed: 29 Jun 65
Geologist: W. G. Binkley

Depth feet	Sample no.	Soil legend	Classification	Formation description & remarks
	1	ML	Sandy SILT F-4	Silty fine sand with very small amount organic material; ranges to a sandy silt.
2				
4				
				Fine sand, very silty.
6	2			

6.6' Final Depth stopped by running sand.

NOTE: Location not surveyed.

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-40

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 91,720 E 92,405 — Drilling agency: Corps of Engineers
Hole No.: Field AH-41, Permanent AH-41
Type of hole: Auger hole — Total depth of hole: 8.5
Size and type of bit: 4" Auger
Total no. of samples: Three — Type of samples: Disturbed — Depth to ground water: 0 — Started: 30 Jun 65 — Completed: 30 Jun 65
Geologist: W. G. Binkley

Depth feet	Sample no.	Soil legend	Classification	Formation description & remarks
	1	ML	Sandy SILT F-4	Fine sandy silt, with grass roots.
2				
4	2			Silty fine sand, rare organic material.
6				
8	3			

8.5' Final Depth

NOTE: Location not surveyed.

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-41

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 91,600 E 92,238 — Drilling agency: Corps of Engineers
Hole No.: Field AH-42, Permanent AH-42 — Name of driller: O'Brien & Richmond — Weather: Overcast
Type of hole: Auger hole — Total depth of hole: 8.6
Size and type of bit: 4" Auger — Type of equipment: Hand Auger, 4"
Total no. of samples: Two — Type of samples: Disturbed — Depth to ground water: 0 — Started: 30 Jun 65 — Completed: 30 Jun 65
Geologist: W. G. Binkley

Depth feet	Sample no.	Soil legend	Classification	Formation description & remarks
	1	ML	Sandy SILT F-4	Light gray sandy silt, with common grass-roots.
2				
4				
6				Light gray silty fine sand; similar to that above, but increase in sand content.
8	2	ML	SILT F-4	

8.6 ft., Final Depth; hole stopped by running sand.

NOTE: Location not surveyed.

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-42

...ENT OF THE ARMY
...PACIFIC DIVISION
...ENGINEER DISTRICT, ALASKA
...LORATION LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1
LOCATION: N 92,024 E 91,971
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO. PERMANENT: AH-38
NAME OF DRILLER: Richmond & O'Brien — WEATHER: Fair
TYPE OF HOLE: AUGER HOLE
TOTAL DEPTH OF HOLE: 5.8'
TYPE OF EQUIPMENT: Hand Auger, 4"
TYPE OF SAMPLES: Disturbed
DEPTH TO GROUND WATER: 0 — DATE HOLE STARTED: 29 Jun 65 — COMPLETED: 29 Jun 65
W. C. Binkley

SAMPLE NO	SOIL LEGEND	CLASSIFICATION		FORMATION DESCRIPTION & REMARKS
1	ML	Sandy SILT	F-4	Silty, fine sand, light gray (dry), brown-gray (wet)
				Hole dug below watertable for entire depth; troubled by running sands.
	SP-SM	Silty SAND	F-2	
2				
	NOTE:	Location not surveyed.		

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-38

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1
LOCATION: N 91,976 E 92,030
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO. FIELD: AH-39 PERMANENT: AH-39
NAME OF DRILLER: Richmond & O'Brien — WEATHER: Fair
TYPE OF HOLE: AUGER HOLE
TOTAL DEPTH OF HOLE: 6.8
SIZE AND TYPE OF BIT: 4" Auger
TYPE OF EQUIPMENT: Hand Auger, 4"
TOTAL NO. OF SAMPLES: 2 — TYPE OF SAMPLES: Disturbed
DEPTH TO GROUND WATER: 0 — DATE HOLE STARTED: 6/29/65 — COMPLETED: 6/29/65
W. C. Binkley

DEPTH FEET	WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION		FORMATION DESCRIPTION & REMARKS
		1	ML	Sandy SILT		Silty fine sand, light gray (dry) to dark brown-gray (wet). Small amount organic material.
2			SM	Silty SAND	F-2	
4						Hole dug below high-tide and below water table, difficult digging due to running sands.
6						
		2		6.8' final depth, stopped by running sands.		
			NOTE:	Location not surveyed.		

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-39

...ENT OF THE ARMY
...PACIFIC DIVISION
...ENGINEER DISTRICT, ALASKA
...LORATION LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1
LOCATION: N 91,435 E 92,096
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO. PERMANENT: AH-43
NAME OF DRILLER: O'Brien & Richmond — WEATHER: Overcast
TYPE OF HOLE: AUGER HOLE
TOTAL DEPTH OF HOLE: 7.0'
TYPE OF EQUIPMENT: Hand Auger, 4"
TYPE OF SAMPLES: Disturbed
DEPTH TO GROUND WATER: 0 — DATE HOLE STARTED: 30 Jun 65 — COMPLETED: 30 Jun 65
W. C. Binkley

SAMPLE NO	SOIL LEGEND	CLASSIFICATION		FORMATION DESCRIPTION & REMARKS
	ML	SILT	F-4	Light gray sandy silt, many grass-roots.
	ML	Sandy SILT	F-4	Light gray sandy silt, with very few grass-roots.
	ML	SILT	F-4	Sandy silt as above.

...inal Depth. Hole stopped by running sand.
Hole was full of water while being drilled.
NOTE: Location not surveyed.

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-43

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
AUGER HOLE LOG
LOG RECORDS NO. 6

DESIGNED: Wm. Trautwein
DRAWN: Wm. Trautwein
CHECKED: D. Hansen
PREPARED:
SUPERVISED: M. C. Dixon, CHIEF, GEOLOGY SECTION
SUBMITTED: CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George, CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 66
FILE NUMBER
SHEET OF

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

- Project: SNETTISHAM — Sheet 1 of 1
- Location: N 91,260 E 91,966
- Drilling agency: Corps of Engineers
- Hole No.: Field AH-44, Permanent AH-44
- Name of driller: O'Brien & Richmond
- Weather: Overcast/rain
- Type of hole: Auger hole
- Total depth of hole: 8.0
- Size and type of bit: 4" Auger
- Type of equipment: Hand Auger, 4"
- Total no. of samples: 2
- Type of samples: Disturbed
- Depth to ground water: 0
- Date hole started: 1 Jul 65; completed: 1 Jul 65
- Geologist: W. C. Binkley

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		1	ML	SILT F-4		Light gray sand silt, abundant grass roots.
8		2	ML	SILT F-4		Dark gray carbonaceous silt and sandy silt.

8.0' Final Depth. Hole stopped by running sand.

NOTE: Location not surveyed.

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PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-44

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

- Project: SNETTISHAM — Sheet 1 of 1
- Location: N 91,006 E 91,764
- Drilling agency: Corps of Engineers
- Hole No.: Field AH-45, Permanent AH-45
- Name of driller: O'Brien & Richmond
- Weather: Rainy
- Type of hole: Auger hole
- Total depth of hole: 8.0
- Size and type of bit: 4" Auger
- Type of equipment: Hand Auger, 4"
- Total no. of samples: 2
- Type of samples: Disturbed
- Depth to ground water: 0
- Date hole started: 1 Jul 65; completed: 1 Jul 65
- Geologist: W. C. Binkley

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		1	ML	Sandy SILT F-4		Silty fine sand, with common grass-roots.
8		2	ML	Sandy SILT F-4		Sandy dark gray silt, not organic.

8.0 FINAL DEPTH
Stopped by running sands.
Hole full of water.

NOTE: Location not surveyed.

NPA FORM DEC 1959 19 (REV)

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-45

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

- Project: SNETTISHAM — Sheet 1 of 1
- Location: N 90,833 E 91,611
- Drilling agency: Corps of Engineers
- Hole No.: Field AH-46, Permanent AH-46
- Name of driller: O'Brien & Richmond
- Weather: Rain
- Type of hole: Auger hole
- Total depth of hole: 8.2
- Size and type of bit: 4" Auger
- Type of equipment: Hand Auger, 4"
- Total no. of samples: Three
- Type of samples: Distrubed
- Depth to ground water: 0
- Date hole started: 1 Jul 65; completed: 1 Jul 65
- Geologist: W. C. Binkley

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		1	ML	SILT F-4		Dark gray carbonaceous sandy silt, with common grass roots.
		2	ML	SILT F-4		Dark gray and light gray silty sand, with few carbonaceous streaks.
8		3	ML	Sandy SILT F-4		Med gray silty sand, with rare pebbles 1" (-).

8.2 ft, Final Depth. Stopped by running sands in hole full of water.

NOTE: Location not surveyed.

NPA FORM DEC 1959 19 (REV)

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-46

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

- Project: Glacier Creek Fan, SNETTISHAM — Sheet 1 of 1
- Location: N 93,171 E 94,514
- Drilling agency: Corps of Engineers
- Hole No.: Field AH-49, Permanent AH-49
- Name of driller: O'Brien, Huzarski
- Weather: Clear & sunny
- Depth drilled into: 5.2
- Type of hole: Auger hole
- Total depth of hole: 5.2
- Size and type of bit: 4" Auger
- Type of equipment: Hand Auger
- Total no. of samples: Three
- Type of samples: Disturbed
- Depth to ground water: 3.5
- Date hole started: 10 Jul 65; completed: 10 Jul 65
- Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		49A		Silty SAND		Fine grained sand and rock flour, tan, some organic silt.
2.0				SAND		Fine to med grained, tan, clean.
						Water Table Running sand below water surface.
5.0		49B 49C				

NOTE: 1. Location approximate.
2. No lab test to date on samples.

NPA FORM DEC 1959 19 (REV)

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-49

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

- Project: Glacier Creek Fan, SNETTISHAM — Sheet 1 of 1
- Location: N 93,450 E 94,631
- Drilling agency: Corps of Engineers
- Hole No.: Field AH-50, Permanent AH-50
- Name of driller: O'Brien, Huzarski
- Weather: Clear & sunny
- Type of hole: Auger hole
- Total depth of hole: 3.5
- Size and type of bit: 4" Auger
- Type of equipment: Hand Auger
- Total no. of samples: Four
- Type of samples: Disturbed
- Date hole started: 10 Jul 65; completed: 10 Jul 65
- Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		50A				Water Table
				SAND		Fine to med grained, tan, heaving, saturated, some gravel to 1/2".
3.0		50B 50C 50D				

NOTE: 1. Caving, quick conditions exist below water table - Samples difficult to recover. Much contamination.
2. Location approximate.

NPA FORM DEC 1959 19 (REV)

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-50

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

- Project: Glacier Creek Fan, SNETTISHAM — Sheet 1 of 1
- Location: N 93,632 E 94,718
- Drilling agency: Corps of Engineers
- Hole No.: Field AH-51, Permanent AH-51
- Name of driller: O'Brien, Huzarski
- Weather: Clear & sunny
- Type of hole: Auger hole
- Total depth of hole: 3.3
- Size and type of bit: 4" Auger
- Type of equipment: Hand Auger
- Total no. of samples: Two
- Type of samples: Disturbed
- Depth to ground water: 1.0
- Date hole started: 10 Jul 65; completed: 10 Jul 65
- Geologist: Lachel

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		51A				
1.0						Water Table
				Sandy SILT		Gray, fine grained sand and rock flour.
		51B		Silty GRAVEL	3"	Sub-rounded, some limonite staining, predominantly quartz diorite.

NOTE: 1. Hole abandon 3.3 - could not recover material - still in gravel.
2.3' sample recovered by hand.
2. Location approximate.

NPA FORM DEC 1959 19 (REV)

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-51

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 90,657 E 91,428
Drilling Agency: Corps of Engineers
Hole No.: AH-47 — Permanent: AH-47
Name of Driller: O'Brien & Richmond — Weather: Rainy
Type of Hole: Auger Hole
Total Depth of Hole: 5.5
Type of Equipment: Hand auger, 4"
Type of Samples: Disturbed
Date Hole Started: 2 Jul 65 — Completed: 2 Jul 65
Geologist: W. C. Binkley

Sample No.	Soil Legend	Classification		Formation Description & Remarks
1	ML	SILT	F-4	Silt, slightly clayey and slightly plastic; lt. gray, with dark gray carbon streaks; Common grass roots.
	ML	Sandy Silt	F-4	Silt, slightly sandy, with few pebbles 1" (-); few grass roots.
2				
3	SM	Gravelly Silty SAND		

5.5' Final Depth
Stopped by running sand and gravel, in hole full of water.

NOTE: Location not surveyed.

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-47

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 90,470 E 91,220
Drilling Agency: Corps of Engineers
Hole No.: Field AH-48 — Permanent: AH-48
Name of Driller: O'Brien & Richmond — Weather: Rainy
Type of Hole: Auger Hole
Total Depth of Hole: 5.5
Size and Type of Bit: 4" Auger
Type of Equipment: Hand auger, 4"
Total No. of Samples: 3 — Type of Samples: Disturbed
Depth to Ground Water: 0
Date Hole Started: 2 Jul 65 — Completed: 2 Jul 65
Geologist: W. C. Binkley

Depth Feet	Sample No.	Soil Legend	Classification		Formation Description & Remarks
	1	SM	Silty SAND	F-2	Slightly silty sand, med. grain, common grass roots.
2	2	ML	Sandy SILT	F-4	Silty sand, fine to very fine
4		ML			Silty sand, few pebbles to 1".

5.5' FINAL DEPTH
Stopped by running sand and gravel; hole full of water.

NOTE: Location not surveyed.

DPM FORM 1959 (REV)

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-48

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Glacier Creek Fan SNETTISHAM — Sheet 1 of 1
Location: N 93,820 E 94,800
Drilling Agency: Corps of Engineers
Hole No.: Permanent AH-52
Name of Driller: O'Brien, Huzarski — Weather: Clear & sunny
Type of Hole: Auger Hole
Total Depth of Hole: 1.0
Type of Equipment: Hand Auger
Type of Samples: Disturbed
Date Hole Started: 10 Jul 65 — Completed: 10 Jul 65
Geologist: Lachel

Sample No.	Soil Legend	Classification	Max Size Particle	Formation Description & Remarks
52A		Silty Sandy GRAVEL	1.5"	Organic material (roots, grass). Fine to coarse grained sand. Gravel sub-rounded, predominantly qtz. diorite.

NOTE:
1. Hole abandon 1.0 due to refusal on gravel, test pit to be dug at point.
2. Location approximate.

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-52

Revision	Date	Description	By

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm Trautwein
DRAWN: Wm Trautwein
CHECKED: D Hansen
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
AUGER HOLE LOG
LOG RECORDS NO. 7

SUPERVISED: M A Dixon — CHIEF, GEOLOGY SECTION
SUBMITTED: CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Warren George — CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, CE, DISTRICT ENGINEER
SCALE — DATE 20 Oct 65
FILE NUMBER
SHEET OF

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

PROJECT: Glacier Creek Fan, SNETTISHAM — SHEET 1 OF 1
LOCATION (Coordinates or Station): N 94,880 E 94,880
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO: FIELD AH-53, PERMANENT AH-53
NAME OF DRILLER: O'Brien, Huzarski — WEATHER: Clear & sunny
TYPE OF HOLE: AUGER HOLE
SIZE AND TYPE OF BIT: 4" Auger — TYPE OF EQUIPMENT: Hand Auger
TOTAL NO OF SAMPLES: None — DATE HOLE STARTED: 10 July 65 — COMPLETED: 10 Jul 65
Geologist: Lachel

DEPTH FEET	WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				Gravels and boulders at surface to 15" materials too large to dig with auger. Test pit will be dug at later date. Location at Sta. 0+00 Lower campsite baseline.		

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-53

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

PROJECT: Glacier Creek Fan, SNETTISHAM — SHEET 1 OF 1
LOCATION (Coordinates or Station): N 93,376 E 95,155
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO: FIELD AH-54, PERMANENT AH-54
NAME OF DRILLER: O'Brien & Richmond — WEATHER: Cloudy
TOTAL DEPTH OF HOLE: 1.9
TYPE OF HOLE: AUGER HOLE
SIZE AND TYPE OF BIT: 4" Auger — TYPE OF EQUIPMENT: Hand Auger
TOTAL NO OF SAMPLES: Two — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: 0.0
DATE HOLE STARTED: 12 Jul 65 — COMPLETED: 1 Jul 65
Geologist: Lachel

DEPTH FEET	WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
		54A				
				SAND		Fine to med grained, tan, angular, some rock flour, mica flakes
1.0						
		54B				
2.0				Abandon 1.9 due to caving.		

NOTE: 1. Location in small stream, all samples taken below water table, some gravel to 2" on surface.
2. Location approximate.

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-54

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

PROJECT: Glacier Creek Fan, SNETTISHAM — SHEET 1 OF 1
LOCATION (Coordinates or Station): N 92,892 E 94,786
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO: FIELD AH-57, PERMANENT AH-57
NAME OF DRILLER: Richmond — WEATHER: Partly Cloudy
TOTAL DEPTH OF HOLE: 2.0
TYPE OF HOLE: AUGER HOLE
SIZE AND TYPE OF BIT: 4" Auger — TYPE OF EQUIPMENT: Hand Auger
TOTAL NO OF SAMPLES: One — TYPE OF SAMPLES: Disturbed — DEPTH TO GROUND WATER: 0.6
DATE HOLE STARTED: 13 Jul 65 — COMPLETED: 13 Jul 65
Geologist: Lachel

DEPTH FEET	WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				Silty SAND		Gray, fine grained, some small gravel on surface in area.
				Water Table		
1.0		57A		SAND	6"	Fine to coarse grained, some silt.
2.0						

NOTE: 1. Abandon 2.0 sides caving, contamination running sand.
2. Location approximate.

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-57

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1
LOCATION (Coordinates or Station): N E
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO: FIELD AH-60, PERMANENT AH-60
NAME OF DRILLER: O'Brien & Fox — WEATHER: Cloudy
DEPTH DRILLED INTO: 7.5' — TOTAL DEPTH OF HOLE: 7.5'
TYPE OF HOLE: AUGER HOLE
SIZE AND TYPE OF BIT: 4" Hand Auger — TYPE OF EQUIPMENT: Hand Auger
TOTAL NO OF SAMPLES: 4 — TYPE OF SAMPLES: Disturbed
DATE HOLE STARTED: 16 Jul 65 — COMPLETED: 16 Jul 65
Geologist: Hansen

DEPTH FEET	WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
		1		SILT		Gray, non plastic, with grass roots.
2		2		Sandy SILT		Gray, fine
4						
6		3		Sandy SILT		Gray, fine, some organic matter.
		4		Sandy SILT		Gray, fine, some organic matter.
8				7.5 feet - Bottom of Hole		

NOTE: 1. Classified in field, no lab tests to date.
2. Location - 10' NW of "P" line station 92+00

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-60

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1
LOCATION (Coordinates or Station): N 94,312 E 92,832
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO: FIELD AH-61, PERMANENT AH-61
NAME OF DRILLER: O'Brien — WEATHER: Rain
DEPTH DRILLED INTO: 7.0' — TOTAL DEPTH OF HOLE: 7.0'
TYPE OF HOLE: AUGER HOLE
SIZE AND TYPE OF BIT: 4" Auger — TYPE OF EQUIPMENT: Hand Auger
TOTAL NO OF SAMPLES: Four — TYPE OF SAMPLES: Disturbed
DATE HOLE STARTED: 16 Jul 65 — COMPLETED: 16 Jul 65
Geologist: Hansen

DEPTH FEET	WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
		1		Sandy SILT		Gray, fine, non plastic with organic matter.
2		2		Sandy SILT		Gray, fine.
4		3		Sandy SILT		Gray, fine.
6		4		Sandy SILT		7.0 feet Bottom of Hole

NOTE: Location - 4' SE of "P" Line Sta 90+00.
Field Classification, no lab test to date.

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-61

DEPARTMENT OF THE ARMY — NORTH PACIFIC DIVISION — U.S. ARMY ENGINEER DISTRICT, ALASKA — EXPLORATION LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1
LOCATION (Coordinates or Station): N 94,149 E 92,715
DRILLING AGENCY: CORPS OF ENGINEERS
HOLE NO: FIELD AH-62, PERMANENT AH-62
NAME OF DRILLER: O'Brien and Fox — WEATHER: Cloudy
DEPTH DRILLED INTO: 3.5' — TOTAL DEPTH OF HOLE: 3.5'
TYPE OF HOLE: AUGER HOLE
SIZE AND TYPE OF BIT: 4" Auger — TYPE OF EQUIPMENT: Hand Auger
TOTAL NO OF SAMPLES: 2 — TYPE OF SAMPLES: Disturbed
DATE HOLE STARTED: 16 Jul 65 — COMPLETED: 16 Jul 65
Geologist: Hansen

DEPTH FEET	WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
		1		Sandy SILT		Non plastic, gray, fine organic matter.
2		2		Sandy SILT		Gray, fine.
4				3.5 feet - Bottom of Hole		

NOTE: 1. Location: 10' NW of "P" Line Sta 88+00.
2. Classified in field, no lab tests to date.

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-62

...OF THE ARMY
...CIFIC DIVISION
...EER DISTRICT, ALASKA
...ATION LOG

PROJECT	Glacier Creek Fan SNETTISHAM
SHEET	1 OF 1
LOCATION	N 92,725 E 96,670
DRILLING AGENCY	CORPS OF ENGINEERS
PERMANENT HOLE NO.	AH-58
NAME OF DRILLER	Richmond
WEATHER	Cloudy
TYPE OF HOLE	AUGER HOLE
TOTAL DEPTH OF HOLE	2.0
TYPE OF EQUIPMENT	Hand Auger
TYPE OF SAMPLES	Disturbed
DEPTH TO GROUND WATER	1.1
DATE HOLE STARTED	15 July 65
DATE HOLE COMPLETED	15 July 65

CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
Silty SAND	Fine to med grained, brown.
SAND	Fine to coarse grained, some silt, gray to brown, angular.
Water Table	
SAND	Fine to med grained, gray, saturated.

NOTE:
1. Flowing sand below watertable, caving impossible to dig with auger.
2. Location approximate.

PROJECT SNETTISHAM PERMANENT HOLE NO. AH-58

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U S ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT	Glacier Creek Fan SNETTISHAM
SHEET	1 OF 1
LOCATION	N 92,600 E 94,525
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO. FIELD	AH-59
PERMANENT	AH-59
NAME OF DRILLER	Richmond
WEATHER	Cloudy
TYPE OF HOLE	AUGER HOLE
TOTAL DEPTH OF HOLE	2.3
SIZE AND TYPE OF BIT	4" Auger
TYPE OF EQUIPMENT	Hand Auger
TOTAL NO. OF SAMPLES	One
TYPE OF SAMPLES	Disturbed
DEPTH TO GROUND WATER	1.2
DATE HOLE STARTED	14 Jul 65
DATE HOLE COMPLETED	15 Jul 65
GEOLOGIST	D. J. Lachel

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
	59A	SAND	Fine to med grained, Tan, some silt.
1.0		Water Table	
		SAND	Fine to med grained, tan.
2.0			

NOTE:
1. Impossible to dig further with auger due to flowing sand and caving.
2. Location approximate.

NPA FORM 1899 (REV)

PROJECT SNETTISHAM PERMANENT HOLE NO. AH-59

...OF THE ARMY
...IC DIVISION
...DISTRICT, ALASKA
...LOG

PROJECT	SNETTISHAM
SHEET	1 OF 1
LOCATION	N 93,975 E 92,605
DRILLING AGENCY	CORPS OF ENGINEERS
PERMANENT HOLE NO.	AH-63
NAME OF DRILLER	O'Brien and Fox
WEATHER	Cloudy
DEPTH DRILLED INTO	7.0'
TOTAL DEPTH OF HOLE	7.0'
TYPE OF EQUIPMENT	Hand Auger
TYPE OF SAMPLES	Disturbed
DATE HOLE STARTED	16 Jul 65
DATE HOLE COMPLETED	16 Jul 65

CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
Sandy SILT	Non plastic, gray, fine, organic matter.
Sandy SILT	Gray, fine.
Sandy SILT	Gray, fine

7.0 feet - Bottom of Hole

NOTE:
1. Location 10' SE of "P" Line Sta 86+00.
2. Classified in field - no lab tests to date.

PROJECT SNETTISHAM PERMANENT HOLE NO. AH-63

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
AUGER HOLE LOG
LOG RECORDS NO. 8

DESIGNED: Wm B. Trautwein
DRAWN: Wm B. Trautwein
CHECKED: D. Hansen
PREPARED:
SUPERVISED: [signature] CHIEF, GEOLOGY SECTION
SUBMITTED: [signature] CHIEF, F & M BRANCH
RECOMMENDED: [signature] CHIEF, ENGINEERING DIVISION
APPROVED: [signature] COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N [illegible] E [illegible] — Drilling agency: Corps of Engineers
Hole No.: Field AH-64, Permanent AH-64 — Name of driller: O'Brien & Fox — Weather: Cloudy
Type of hole: Auger hole — Depth drilled into: 8.6' — Total depth of hole: 8.6'
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: 4 — Type of samples: Disturbed — Date hole started: 17 Jul 65, completed: 17 July 65
Geologist: Hansen

Depth (feet)	Sample No.	Classification	Formation Description & Remarks
	1	Sandy SILT	Non plastic, fine, gray with organic matter.
2	2	Sandy SILT	Fine, gray.
6	3	Sandy SILT	
8	4	Sandy SILT	

8.6 feet - Bottom of Hole

NOTE: 1. Location 10' NW of "P" line sta. 84+00.
2. Classified in field, no lab tests to date.

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PROJECT SNETTISHAM — PERMANENT HOLE NO AH-64

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 93,637 E 92,372 — Drilling agency: Corps of Engineers
Hole No.: Field AH-65, Permanent AH-65 — Name of driller: O'Brien & Fox — Weather: Cloudy
Type of hole: Auger hole — Depth drilled into: 8.9' — Total depth of hole: 8.9'
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: 4 — Type of samples: Disturbed — Date hole started: 17 Jul 65, completed: 17 July 1965
Geologist: Hansen

Depth (feet)	Sample No.	Classification	Formation Description & Remarks
	1	Sandy SILT	Non plastic, gray, fine with organic matter.
2	2	Sandy SILT	Gray, fine.
4	3	Sandy SILT	
8	4		

8.9 feet - Bottom of Hole

NOTE: 1. Location 20' NW of "P" line sta. 82+00
2. Classified in field, no lab tests to date.

NPA FORM 19 (REV) DEC 1959

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-65

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 93,482 E 92,250 — Drilling agency: Corps of Engineers
Hole No.: Field AH-66, Permanent AH-66 — Name of driller: O'Brien & Fox — Weather: Cloudy
Type of hole: Auger hole — Depth drilled into: 9.1' — Total depth of hole: 9.1'
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: 5 — Type of samples: Disturbed — Date hole started: 17 Jul 65, completed: 17 Jul 65
Geologist: Hansen

Depth (feet)	Sample No.	Classification	Formation Description & Remarks
	1	Sand, SILT	Non plastic, gray, fine with organic matter.
2	2	Sandy SILT	Gray, fine.
4	3	Sandy SILT	Gray, fine.
6	4	Sandy SILT	Gray, fine.
8	5	Sandy SILT	Gray, fine.

9.1 feet - Bottom of Hole

NOTE: 1. Location 10' SE of "P" line sta. 80+00.
2. Classified in field, no lab tests to date.

NPA FORM 19 (REV) DEC 1959

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-66

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 93,275 E 91,730 — Drilling agency: Corps of Engineers
Hole No.: Field AH-69, Permanent AH-69 — Name of driller: Richmond & Fox — Weather: Cloudy
Type of hole: Auger hole — Depth drilled into: 6.8' — Total depth of hole: 6.8'
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: 2 — Type of samples: Disturbed — Date hole started: 21 Jul 65, completed: 21 Jul 65
Geologist: Hansen

Depth (feet)	Sample No.	Classification	Formation Description & Remarks
	1	Sandy SILT	Non plastic, gray, fine, with organic matter.
6.8		Sandy SILT	Gray, fine.

6.8 feet - Bottom of Hole

NOTE: 1. Location 8' NW of "P" line sta 74+00.
2. Auger stopped against rock or large boulder.
3. Classified in field, no lab test to date.

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PROJECT SNETTISHAM — PERMANENT HOLE NO AH-69

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 93,155 E 91,550 — Drilling agency: Corps of Engineers
Hole No.: Field AH-70, Permanent AH-70 — Name of driller: Richmond & Fox — Weather: Rainy
Type of hole: Auger hole — Depth drilled into: 9.5' — Total depth of hole: 9.5'
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: [illegible] — Type of samples: Disturbed — Date hole started: 21 Jul 65, completed: 21 Jul 65
Geologist: Hansen

Depth (feet)	Sample No.	Classification	Formation Description & Remarks
	1	Sandy SILT	Non plastic, fine, gray with organic matter.
4	2	Sandy SILT	Non plastic, gray, fine.
	3	Organic SILT	Slightly plastic, gray.
	4	Organic SILT	Plastic, gray.

9.5 feet - Bottom of Hole

NOTE: 1. Location 50' SE of "P" line sta 72+00.
2. Classified in field, no lab tests to date.

NPA FORM 19 (REV) DEC 1959

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-70

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: SNETTISHAM — Sheet 1 of 1
Location: N 92,990 E 91,440 — Drilling agency: Corps of Engineers
Hole No.: Field AH-71, Permanent AH-71 — Name of driller: Richmond & Fox — Weather: Rainy
Type of hole: Auger hole — Depth drilled into: 7.4' — Total depth of hole: 7.4'
Size and type of bit: 4" Auger — Type of equipment: Hand Auger
Total no. of samples: Three — Type of samples: Grab — Date hole started: 21 Jul 65, completed: 21 Jul 65
Geologist: Hansen

Depth (feet)	Sample No.	Classification	Formation Description & Remarks
	1	Sandy SILT	Slightly plastic, gray, fine with some organic material and organic silt.
4	2	Sandy SILT	Non plastic, gray, fine.
6	3	G Sandy SILT	Slightly plastic, gray, fine with some organic silt and gravel.

7.4 feet - Bottom of Hole

NOTE: 1. Location, 200' SW'ly from AH-70.
2. Stop due to coarse material or gravel.
3. Classified in field, no lab test as to date.

NPA FORM 19 (REV) DEC 1959

PROJECT SNETTISHAM — PERMANENT HOLE NO AH-71

OF THE ARMY
FIC DIVISION
DISTRICT, ALASKA
LOG

SNETTISHAM — SHEET 1 OF 1

N 93,348 — E 92,119 — CORPS OF ENGINEERS

PERMANENT AH-67 — O'Brien & Fox — Sunny

DEPTH DRILLED INTO 9.0' — TOTAL DEPTH OF HOLE 9.0'

TYPE OF EQUIPMENT: Hand Auger

TYPE OF SAMPLES: Disturbed — DATE HOLE STARTED 20 July 65, COMPLETED 20 Jul 65

CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
Sandy SILT	Non plastic, gray, fine with organic matter.
Sandy SILT	Gray, fine
Sandy SILT	
Sandy SILT	

9.0 feet - Bottom of Hole

NOTE: 1. Location 15' SE of "P" line sta. 76+00.
2. Classified in field, no lab test to date.

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-67

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

SNETTISHAM — SHEET 1 OF 1

N 93,281 — E 91,926 — CORPS OF ENGINEERS

HOLE AH-68 — PERMANENT AH-68 — Richmond & Fox — Cloudy

TYPE OF HOLE: AUGER HOLE — DEPTH DRILLED INTO 9.8' — TOTAL DEPTH OF HOLE 9.8'

SIZE AND TYPE OF BIT: 4" Auger — TYPE OF EQUIPMENT: Hand Auger

TOTAL NO. OF SAMPLES: 3 — TYPE OF SAMPLES: Disturbed — DATE HOLE STARTED 21 Jul 65, COMPLETED 21 Jul 65

Hansen

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
	1	Sandy SILT	Non plastic, gray, fine with organic matter.
2			
	2	Sandy SILT	Fine, gray.
4			
6			
8			
	3	Sandy SILT	Fine, gray.
9.8			

9.8 feet - Bottom of Hole

NOTE: 1. Location - 30' SE of "P" line sta. 78+00.
2. Classified in field, no lab tests to date.

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-68

OF THE ARMY
FIC DIVISION
DISTRICT, ALASKA
LOG

SNETTISHAM — SHEET 1 OF 1

N 92,837 — E 91,321 — CORPS OF ENGINEERS

PERMANENT AH-72 — Richmond & Fox — Cloudy

DEPTH DRILLED INTO 2.0' — TOTAL DEPTH OF HOLE 2.0'

TYPE OF EQUIPMENT: Hand Auger

TYPE OF SAMPLES: Disturbed — DATE HOLE STARTED 21 Jul 65, COMPLETED 21 Jul 65

CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
Sandy SILT	Non plastic, brown, fine, with organic matter.
Sandy gravelly SILT	Brown, fine.

NOTE: 1. Location 200' SW'ly from AH-71.
2. Classified in field, no lab tests to date.

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-72

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm B Trautwein
DRAWN: Wm B Trautwein
CHECKED: D. J. Lackel
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
AUGER HOLE LOG

LOG RECORDS NO. 9

SUPERVISED: M. A. Duron — CHIEF, GEOLOGY SECTION
APPROVED: Clay I. Farley — COLONEL, CE, DISTRICT ENGINEER
SUBMITTED: [signature] — CHIEF, F&M BRANCH
SCALE — DATE 20 Oct 65
FILE NUMBER
RECOMMENDED: Harrison George — CHIEF, ENGINEERING DIVISION
SHEET OF

2

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT: SNETTISHAM — SHEET 1 OF 1

N 92,760 — E 91,145

DRILLING AGENCY: CORPS OF ENGINEERS

NAME OF DRILLER: Richmond & Fox — WEATHER: Cloudy

HOLE NO.: AH-73 — PERMANENT: AH-73

TYPE OF HOLE: AUGER HOLE

TOTAL DEPTH DRILLED INTO: 2.4' — TOTAL DEPTH OF HOLE: 2.4'

SIZE AND TYPE OF BIT: 4" Auger

TYPE OF EQUIPMENT: Hand Auger

TOTAL NO. OF SAMPLES: Two — TYPE OF SAMPLES: Disturbed

DATE HOLE STARTED: 21 Jul 65 — COMPLETED: 21 Jul 65

Hansen

DEPTH FEET	WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION		FORMATION DESCRIPTION & REMARKS
		1		Sandy SILT		Non plastic, brown, fine with organic matter.
2		2		Sandy gravelly SILT		Gray, fine.

2.4 feet - Bottom of Hole

NOTE: 1. Location 200' SW'ly from AH-72
2. Classified in field, no lab test to date.

PROJECT SNETTISHAM — PERMANENT HOLE NO. AH-73

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm. B. Tenthwer
DRAWN: Wm. B. Tenthwer
CHECKED: D.J. Lacasse
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT

AUGER HOLE LOG

LOG RECORDS NO. 10

SUPERVISED: M.A. Dillon
SUBMITTED:
RECOMMENDED: Warren George
APPROVED:
SCALE
DATE 20 Oct 65
FILE NUMBER
SHEET OF

PART 9 LOG RECORDS - WASH PROBES

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 2
LOCATION (Coordinates or Station)	N 88 313 E 92 800
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO. FIELD	PH 1
HOLE NO. PERMANENT	PH 1
NAME OF DRILLER	Swanson
HELPER	Rainy
TYPE OF HOLE	Probe hole
TOTAL DEPTH OF HOLE	20.0
TYPE OF EQUIPMENT	AX drill rods and Bean water pump
TOTAL NO. OF SAMPLES	0
DATE HOLE STARTED	22 Nov
DATE HOLE COMPLETED	22 Nov
GEOLOGIST	R. Velikanje

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				Silty SAND		Fine grained.

NPA FORM 955 (R-REV)

PROJECT Snettisham PERMANENT HOLE NO. PH 1

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT	Snettisham
SHEET	2 OF 2
LOCATION (Coordinates or Station)	N 88313 E 72800
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO. FIELD	PH 1
HOLE NO. PERMANENT	PH 1
NAME OF DRILLER	Swanson
HELPER	Rainy
TYPE OF HOLE	Probe hole
TOTAL DEPTH OF HOLE	20.0
TYPE OF EQUIPMENT	AX drill rods and Bean water pump
TOTAL NO. OF SAMPLES	0
DATE HOLE STARTED	22 Nov
DATE HOLE COMPLETED	22 Nov
GEOLOGIST	R. Velikanje

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				IDEM Silty SAND		
15.0						
16.0						
17.0						
18.0						
19.0						
20.0						

NOTES: 1. Probing made with 30' drill stem with approximately 3/8" ins.de diameter.
2. Water jet produced by attaching bean piston, high pressure, low volume type water pump.
3. Rods dropped with water jet and own weight.

NPA FORM 955 (R-REV)

PROJECT Snettisham PERMANENT HOLE NO. PH 1

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT	Snettisham
SHEET	1 OF 2
LOCATION (Coordinates or Station)	N 88230 E 92700
DRILLING AGENCY	CORPS OF ENGINEERS
HOLE NO. FIELD	PH 2
HOLE NO. PERMANENT	PH 2
NAME OF DRILLER	Swanson
HELPER	Rainy
TYPE OF HOLE	Probe hole
TOTAL DEPTH OF HOLE	24.0'
TYPE OF EQUIPMENT	AX drill rods and Bean water pump
TOTAL NO. OF SAMPLES	0
DATE HOLE STARTED	22 Nov
DATE HOLE COMPLETED	22 Nov
GEOLOGIST	R. Velikanje

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
1.0						
2.0						
3.0						
4.0						
5.0						
6.0		0				
7.0				Silty SAND		Fine Grained
8.0						
9.0						
10.0						
11.0						
12.0						
13.0						
14.0						

NPA FORM 955 (R-REV)

PROJECT Snettisham PERMANENT HOLE NO. PH 2

U. S. ARMY

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT	Snettisham
SHEET	2 OF 2
LOCATION	N 88230 E 92700
DRILLING AGENCY	CORPS OF ENGINEERS / OTHER
HOLE NO.	PH 2
PERMANENT	PH 2
NAME OF DRILLER	
WEATHER	Rainy
TYPE OF HOLE	Probe hole X; TEST PIT; AUGER HOLE; CHURN DRILL
DEPTH TO	
DEPTH DRILLED INTO	
TOTAL DEPTH OF HOLE	24.0
SIZE AND TYPE OF BIT	
DATUM FOR ELEVATION SHOWN	TBM / MSL
TYPE OF EQUIPMENT	AX drill rods and Bean water pump
TOTAL NO. OF SAMPLES	0
TYPE OF SAMPLES	
DEPTH TO GROUND WATER	
DATE HOLE STARTED	22 Nov
DATE HOLE COMPLETED	22 Nov
EL. TOP OF HOLE	
Geologist	R. Velikanje

DEPTH FEET	WATER CONTENT	SAMPLE NO	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				IDEM Silty SAND		
15.0						
16.0						
17.0						
18.0						
19.0						
20.0						
21.0						
22.0						
23.0						
24.0						

NOTES: 1. Probing made with 30' drill stem, with approximately 3/8" inside diameter
2. Water jet produced by attaching, bean piston, high pressure, low volume type water pump.
3. Rods dropped on own weight and water jet. No drop without water jet.

PROJECT Snettisham PERMANENT HOLE NO. PH 2

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: Wm B Trautwein
DRAWN: Wm B Trautwein
CHECKED: DJ Lacher
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
PROBE HOLE LOG
LOG RECORD NO. 1

SUPERVISED: M E Dixon — CHIEF, GEOLOGY SECTION
SUBMITTED: CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: Harris George — CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, CE, DISTRICT ENGINEER
SCALE
DATE
FILE NUMBER
SHEET OF

PART 10 LOG RECORDS - VANE SHEAR

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 2
LOCATION (Coordinates or Station): N 93,458 E 93,058 ("P" Line) Sta 93+75 90' RT
DRILLING AGENCY: Corps of Engineers — Crater Cove
HOLE NO.: FIELD VS-1 PERMANENT VS-1
NAME OF DRILLER: Griffith — WEATHER: Clear
DEPTH TO: -15.5 — TOTAL DEPTH OF HOLE: 19.2
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
TYPE OF SAMPLES: Vane Shear (field), Split Spoon
DATE HOLE STARTED: 15 Sep — COMPLETED: 15 Sep
EL. TOP OF HOLE: +3.7 — GEOLOGIST: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
0–2		Fiborous black, partly decomposed grass and silt
2	Vane shear (field) 1900 lbs/ft²	
3	2460 lbs/ft²	
5	N=8	Grey wet silt, some layers slightly plastic with 6" to 1' layers of black organic silt
7	2330 lbs/ft²	
8–9	N=4	Organic silt
11	1550 lbs/ft²	Grey silt
13	1430 lbs/ft²	Coarse wet sand with occasional gravel

NPA FORM 19 (REV) DEC 1959
PROJECT Snettisham — PERMANENT HOLE NO. ____

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 2 OF 2
LOCATION (Coordinates or Station): N 93,458 E 93,058 "P" Line Sta 93+75 90' RT
DRILLING AGENCY: Corps of Engineers
HOLE NO.: FIELD VS-1 PERMANENT VS-1
NAME OF DRILLER: Griffith — WEATHER: Clear
DEPTH TO: -15.5 — TOTAL DEPTH OF HOLE: 19.2
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
TYPE OF SAMPLES: Vane Shear (field), Split Spoon
DATE HOLE STARTED: 15 Sep — COMPLETED: 15 Sep
EL. TOP OF HOLE: +3.7 — GEOLOGIST: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
14–15	N=5	Coarse wet sand with occasional gravel
17	1550 Lbs/ft²	
17	1800 Lbs/ft²	
18	N=6	
19	N=20	

NPA FORM 19 (REV) DEC 1959
PROJECT ____ PERMANENT HOLE NO. ____

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 2
LOCATION (Coordinates or Station): N 93,975 E 92,605 86+00 "P"
DRILLING AGENCY: Corps of Engineers — Crater Cove
HOLE NO.: FIELD VS-2 PERMANENT VS-2
NAME OF DRILLER: Griffith — WEATHER: Clear
DEPTH TO: -20.5' — TOTAL DEPTH OF HOLE: 23'
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
TYPE OF SAMPLES: Vane Shear (field), Split Spoon
DATE HOLE STARTED: 16 Sep — COMPLETED: 16 Sep
EL. TOP OF HOLE: +2.37 — GEOLOGIST: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
0–2		Fiborous black partly decomposed grass and silt
3	Vane Shear 517 lbs/ft² 1550 lbs/ft² N=8	Grey wet silt, slightly plastic, with 6" to 1' layers of black organic silt
6–7	Shelby Tube #1 ML Nat W. C. 30.9% Non Plastic	
11	775 lbs/ft² 1680 lbs/ft²	
13	N=10	

NPA FORM 19 (REV) DEC 1959
PROJECT ____ PERMANENT HOLE NO. ____

DEPART[MENT OF THE ARMY]
U.S. ARMY E[NGINEER DISTRICT]
FIELD VS-2
EL. TOP OF HOLE 2.37
Depths 14–23

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 2 OF 2
LOCATION (Coordinates or Station): N 93,281 E 91,924 "P" Line Sta 76+00 30' RT
DRILLING AGENCY: Corps of Engineers — Crater Cove
HOLE NO.: FIELD VS-3 PERMANENT VS-3
NAME OF DRILLER: Griffith — WEATHER: Clear
DEPTH TO: -14.8 — TOTAL DEPTH OF HOLE: 17.5
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
TYPE OF SAMPLES: Vane Shear field, Split spoon
DATE HOLE STARTED: 17 Sep — COMPLETED: 17 Sep
EL. TOP OF HOLE: +2.76 — GEOLOGIST: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
14	N=5	Dark grey soft organic silt
15	N=4	
16	N=3	
17	N=2	
17.5		white shells and fine sand

NPA FORM 19 (REV) DEC 1959
PROJECT ____ PERMANENT HOLE NO. ____

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 2
LOCATION (Coordinates or Station): N 93,281 E 91,924 "P" Line Sta 76+00 35' RT
DRILLING AGENCY: Corps of Engineers — Crater Cove
HOLE NO.: FIELD VS-3A PERMANENT VS-3A
NAME OF DRILLER: Griffith — WEATHER: Clear
DEPTH TO: - 19.24 — TOTAL DEPTH OF HOLE: 22
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
TYPE OF SAMPLES: Vane Shear (field), Split Spoon
DATE HOLE STARTED: 18 Sep — COMPLETED: 18 Sep
EL. TOP OF HOLE: 2.76 — GEOLOGIST: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
0–3		Fiborous black, partly decomposed grass and silt.
3–5	Shelby Tube #3 ML Nat W. C. 34.2% Liquid Limit 28.5% Plastic Limit 26.4% Dry Unit Wt. 85.8%	
5–7	Shelby Tube #4 ML Nat W. C. 34.9% Liquid Limit 28.8% Plastic Limit 27.0% Dry Unit Wt. 89.6 lbs/ft³	
8	2070 lbs/ft²	Gray wet silt, some layers slightly plastic, with 6" to 1' layers of black organic silt.
14		Dark gray soft organic silt

NPA FORM 19 (REV) DEC 1959
PROJECT ____ PERMANENT HOLE NO. ____

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 2 OF 2
LOCATION (Coordinates or Station): N 93,281 E 91,924 "P" Line Sta 76+00 35' RT
DRILLING AGENCY: Corps of Engineers — Crater Cove
HOLE NO.: FIELD VS-3A PERMANENT VS-3A
NAME OF DRILLER: Griffith — WEATHER: Clear
DEPTH TO: -19.24 — TOTAL DEPTH OF HOLE: 22
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
TYPE OF SAMPLES: Vane Shear field, Split Spoon
DATE HOLE STARTED: 18 Sep — COMPLETED: 18 Sep
EL. TOP OF HOLE: 2.76 — GEOLOGIST: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
15	780 lbs/ft²	
16–17	650 lbs/ft²	
17–18	1550 lbs/ft²	White shells and fine sand
19–20	N=18	Sand & silt with few pieces of small gravel
21	N=17	

NPA FORM 19 (REV) DEC 1959
PROJECT ____ PERMANENT HOLE NO. ____

DEPART[MENT OF THE ARMY]
NORTH [PACIFIC DIVISION]
U.S. ARMY E[NGINEER DISTRICT]
FIELD VS-4
EL. TOP OF HOLE -6.0
Depths 1–13

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham | Sheet 2 of 2
Location: N. 91,975 E. 92,605
Drilling agency: Sta 86+00 "P" Line
Hole No.: Permanent VS-2
Name of driller: Griffith | Weather: Clear
Depth: 10.5 | Total depth of hole: 13'
Datum for elevation shown: MSL | Type of equipment: Wash boring
Type of samples: Vane Shear (field), Split Spoon
Started: 16 Sep | Completed: 16 Sep
Geologist: Griffith

Classification	Formation description & remarks
N=11	Grey wet silt, slightly plastic with 6" to 1' layers of black organic silt
725 lbs/ft² 930 lbs/ft² (Push by hand) 725 lbs/ft²	Dark grey organic silt
N=10	White shells and sand
N-11	Some small pieces of gravel

PROJECT ______ PERMANENT HOLE NO ______

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham | Sheet 1 of 2
Location: N. 91,281 E. 91,924 "P" Line
Other: Sta 76+00 30' RT | Crater Cove
Hole No.: VS-3 | Permanent VS-3
Name of driller: Griffith | Weather: Clear
Depth: -14.8 | Total depth of hole: 17.5
Datum for elevation shown: MSL | Type of equipment: Wash boring
Type of samples: Vane Shear field, Split spoon
Started: 17 Sep | Completed: 17 Sep
El. top of hole: +2.76 | Geologist: Griffith

Depth (feet)	Classification	Formation description & remarks
0–3		Fiborous black, partly decomposed grass and silt
3	1370 lbs/ft²	
4	Shelby Tube No. 2 ML Nat W. C. 31.6% non-plastic Dry unit wt. 91.8 lbs/ft³	
5–6	1810 lbs/ft² 1550 lbs/ft² 1210 lbs/ft² 1040 lbs/ft²	
8	780 lbs/ft²	Gray wet silt, some layers slightly plastic with 6" to 1' layers of black organic silt.
9	N=11	
10	N=13	
13	1870 lbs/ft²	
	N=5	Dark grey soft organic silt

PROJECT ______ PERMANENT HOLE NO ______

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham | Sheet 1 of 2
Location: N. 89,896 E. 92,406
Drilling agency: Star Cove | Corps of Engineers
Hole No.: Permanent VS-4
Name of driller: Griffith
Depth: -2.60 | Total depth of hole: 20.0
Datum for elevation shown: MSL | Type of equipment: Wash boring
Type of samples: Vane Shear (field), Split spoon
Started: 20 Sep 65 | Completed: 20 Sep 65
Geologist: Griffith

Classification	Formation description & remarks
Vane Shear 905 lbs/ft² " " 1030 lbs/ft²	Grey silt with black layers of organic silt
520 lb/ft² 450 lb/ft² 450 lb/ft² (Pushed by Hand)	
259 lb/ft² 196 lb/ft² 259 lb/ft²	Soft grey black organic silt with some silt and wood
End of Casing NX N=1 N=1	Pushed 2" Spoon to a depth of 20 ft

PROJECT ______ PERMANENT HOLE NO ______

Revision	Date	Description	By

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

Designed: R. Griffith
Drawn: R. Griffith
Checked: D. Hansen
Prepared:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
VANE SHEAR

LOG RECORDS NO. 1

Supervised: M. Dixon, Chief, Geology Section
Submitted: Chief, Foundations & Materials Branch
Recommended: Chief, Engineering Division
Approved: Colonel, CE, District Engineer
Scale | Date: 20 Oct 65 | File Number
Sheet of

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 2 OF 2
LOCATION: N 89,895 E 92,405
DRILLING AGENCY: Corps of Engineers / Other: Star Cove
HOLE NO.: FIELD VS-4 PERMANENT VS-4
NAME OF DRILLER: Griffith
DEPTH TO: -26.0 — TOTAL DEPTH OF HOLE: 20.0
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
TYPE OF SAMPLES: Vane Shear (field), Split Spoon
DATE HOLE STARTED: 20 Sep 65 COMPLETED: 20 Sep 65
EL. TOP OF HOLE: -6.0 — Geologist: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
14–20	Pushed 2" Spoon to a Depth of 20 ft by hand	Soft grey black organic silt with some silt and wood

NPA FORM 19 (REV) — PROJECT — PERMANENT HOLE NO.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 1 OF 3
LOCATION: N 88,550 E 93,090
DRILLING AGENCY: Corps of Engineers / Other: Star Cove
HOLE NO.: FIELD VS-5 PERMANENT VS-5
NAME OF DRILLER: Griffith
DEPTH TO: -43.0 — TOTAL DEPTH OF HOLE: 33.5'
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
DATE HOLE STARTED: 20 Sep 65 COMPLETED: 20 Sep 65
EL. TOP OF HOLE: -9.5' — Geologist: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
1	Vane shear 259 lb/ft^2	Medium Fine Sand, some silt and some small layers of organic silt
2–3	170 lb/ft^2 364 lb/ft^2 259 lb/ft^2 170 lb/ft^2	
4	N=3	
6	1430 lb/ft^2 1550 lb/ft^2	
7	N=11	
8	N=1 Lost Sample	
9	N=4	
12	1430 lb/ft^2	
13	N=5 Lost sample	

NPA FORM 19 (REV) — PROJECT — PERMANENT HOLE NO.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 2 OF 3
LOCATION: N 88,550 E 93,090
DRILLING AGENCY: Corps of Engineers / Other: Star Cove
HOLE NO.: FIELD VS-5 PERMANENT VS-5
NAME OF DRILLER: Griffith
DEPTH TO: -43.0' — TOTAL DEPTH OF HOLE: 33.5'
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
DATE HOLE STARTED: 20 Sep 65 COMPLETED: 20 Sep 65
EL. TOP OF HOLE: -9.5' — Geologist: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
14–17	N=5 N=3 Lost Sample N=2 N=1	Medium fine sand, some silt and some small layers of organic silt
19–20	Bottom of NX Casing 1170 lb/ft^2	Artesian pressure present, soil washes up into casing after making vane shear test
21–23	N=5 N=4 Lost Sample N=2	
25	N=5	
26	N=5 Lost Sample	
27	910 lb/ft^2	

NPA FORM 19 (REV) — PROJECT — PERMANENT HOLE NO.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 2 OF 4
LOCATION: N 88,360 E 92,970
DRILLING AGENCY: Corps of Engineers / Other: Star Cove
HOLE NO.: FIELD VS-6 PERMANENT VS-6
NAME OF DRILLER: Griffith
DEPTH TO: -54.5 — TOTAL DEPTH OF HOLE: 43.5'
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
DATE HOLE STARTED: 20 Sep 65 COMPLETED: 20 Sep 65
EL. TOP OF HOLE: -11.0' — Geologist: Griffith

DEPTH FEET	SAMPLE NO.	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
14–18	36 47 47 56 60	Blows per foot on NX casing using 275 lb. hammer, 15.3 in. drop	Very fine sand and silt, some small layers of organic gravel
20		N=2	
21		N=3	
22		N=2	
24		N=4	Medium fine sand, some gravel and silt
25		N=9	
26		N=11	
27		N=13 Bottom of NX Casing	Artesian pressure present

NPA FORM 19 (REV) — PROJECT — PERMANENT HOLE NO.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 3 OF 4
LOCATION: N 88,360 E 92,970
DRILLING AGENCY: Corps of Engineers / Other: Star Cove
HOLE NO.: FIELD VS-6 PERMANENT VS-6
NAME OF DRILLER: Griffith
DEPTH TO: -54.5 — TOTAL DEPTH OF HOLE: 43.5
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
DATE HOLE STARTED: 20 Sep 65 COMPLETED: 20 Sep 65
EL. TOP OF HOLE: -11.0 — Geologist: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
29	N=5	Medium fine sand, some gravel & silt
30	N=6	Fine sand and silt, some layers of organic silt
31	N=6	
32	N=7	
38	N=	
39	N=	
41	N=	

NPA FORM 19 (REV) — PROJECT — PERMANENT HOLE NO.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Snettisham — SHEET 4 OF 4
LOCATION: N 88,360 E 92,970
DRILLING AGENCY: Corps of Engineers / Other: Star Cove
HOLE NO.: FIELD VS-6 PERMANENT VS-6
NAME OF DRILLER: Griffith
DEPTH TO: -54.5 — TOTAL DEPTH OF HOLE: 43.5'
DATUM FOR ELEVATION SHOWN: MSL — TYPE OF EQUIPMENT: Wash boring
DATE HOLE STARTED: 20 Sep 65 COMPLETED: 20 Sep 65
EL. TOP OF HOLE: -11.0 — Geologist: Griffith

DEPTH FEET	CLASSIFICATION	FORMATION DESCRIPTION & REMARKS
42	N=11	Fine sand and silt, some layers of organic silt
43	N=12	

NPA FORM 19 (REV) — PROJECT — PERMANENT HOLE NO.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Drilling agency: Star Cove — Corps of Engineers
Hole No.: Field VS-5; Permanent VS-5
Name of driller: Griffith
Depth to: -43.0 — Total depth of hole: 33.5'
Datum for elevation shown: MSL — Type of equipment: Wash boring
Date hole: Started 20 Sep 65; Completed 20 Sep 65
El. top of hole: -9.5' — Geologist: Griffith

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
29				N=7		Medium fine sand, some silt and some small layers of organic silt
30				N=7		
31				N=7		
32				N=9		
33				N=7		
34						
35						
36						

NPD Form 10 (REV) DEC 1959
PROJECT ______ PERMANENT HOLE NO ______

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 6
Location: N 88,360 E 92,[illegible]
Drilling agency: Star Cove — Corps of Engineers
Hole No.: Field VS-6; Permanent VS-6
Name of driller: Griffith
Depth to: -54.5 — Total depth of hole: 43.5
Datum for elevation shown: MSL — Type of equipment: Wash boring
Date hole: Started 20 Sep 65; Completed 20 Sep 65
El. top of hole: -11.0' — Geologist: Griffith

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
		4	Blows/ft	Blows per foot on NX Casing using 275 lb hammer, 15.3 in. drop		Very fine sand & silt, some small layers of organic silt
1		10	" "			
2		10	" "			
3		9	" "			
4		14	" "			
5		13	" "			
6		14	" "			
7		9	" "			
8		11	" "			
9		10	" "			
10		25	" "			
11		25	" "			
12		27	" "			
13		32	" "			

NPD Form 10 (REV) DEC 1959
PROJECT ______ PERMANENT HOLE NO ______

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project: Snettisham — Sheet 1 of 5
Location: N 88,680 E 92,855
Drilling agency: Star Cove — Corps of Engineers
Hole No.: Field VS-7; Permanent VS-7
Name of driller: Griffith
Depth to: -75.0' — Total depth of hole: 67.0
Datum for elevation shown: MSL — Type of equipment: Wash boring
Date hole: Started 20 Sep 65; Completed 20 Sep 65
El. top of hole: -8.0' — Geologist: Griffith

Depth feet	Water content	Sample no.	Soil legend	Classification	Max size particle	Formation description & remarks
1	365 lb/ft^2					Grey silt with black layers of organic silt
2						
3						
4						
5	320 lb/ft^2					
6						Organic and silt with large layers of fine sand
7	259 lb/ft^2					
8						
9				N=1		
10						
11						
12	324 lb/ft^2			Bottom of NX Casing; Pushed by hand		
13	324 lb/ft^2			Pushed by hand		

NPD Form 10 (REV) DEC 1959
PROJECT ______ PERMANENT HOLE NO ______

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: R. Griffith
DRAWN: R. Griffith
CHECKED: D. Hansen
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
VANE SHEAR
LOG RECORDS NO. 2

SUPERVISED: M. A. Dixon — CHIEF, GEOLOGY SECTION
SUBMITTED: [signature] — CHIEF, FOUNDATIONS & MATERIALS BRANCH
RECOMMENDED: [signature] — CHIEF, ENGINEERING DIVISION
APPROVED: [signature] — COLONEL, CE, DISTRICT ENGINEER
SCALE — DATE 20 Oct 65
FILE NUMBER
SHEET OF

2

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	2 of 5
Location	N 88,680 E 92,855
Drilling agency	Corps of Engineers
Name of driller	Griffith
Remarks	Star Cove
Field hole no.	VS-7
Permanent hole no.	VS-7
Depth to	-75.0'
Total depth of hole	67.0
Datum for elevation shown	MSL
Date hole started	20 Sep 65
Date hole completed	20 Sep 65
El. top of hole	-8.0'
Geologist	Griffith

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
		324	lb/ft²	Pushed by hand	Organic silt and silt with large layers of fine sand
15		259	lb/ft²		
16					
17					
18					
19					
20				N=1	
21				N=2	
22				N=3	
23				N=3	
24				N=2	
25					
26					
27					

NPA FORM 19 (REV) DEC 1959

PROJECT ______ PERMANENT HOLE NO ______

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	3 of 5
Location	N 88,680 E 92,855
Drilling agency	Corps of Engineers
Name of driller	Griffith
Remarks	Star Cove
Field hole no.	VS-7
Permanent hole no.	VS-7
Depth to	-75.0'
Total depth of hole	67.0
Datum for elevation shown	MSL
Type of equipment	Wash boring
Date hole started	20 Sep 65
Date hole completed	20 Sep 65
El. top of hole	-8.0'
Geologist	Griffith

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
					Organic silt and silt with large layers of fine sand
29					
30					
31				N=3	
32				N=3	
33				N=3	
34				N=3	
35					
36					
37					
38				N=3	
39				N=6	
40				N=7	
41				N=7	

NPA FORM 19 (REV) DEC 1959

PROJECT ______ PERMANENT HOLE NO ______

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

Project	Snettisham
Sheet	4 of 5
Location	N 88,680 E 92,855
Drilling agency	Corps of Engineers
Name of driller	Griffith
Remarks	Star Cove
Field hole no.	VS-7
Permanent hole no.	VS-7
Depth to	-75.0'
Total depth of hole	67.0
Datum for elevation shown	MSL
Type of equipment	Wash boring
Date hole started	20 Sep 65
Date hole completed	20 Sep 65
El. top of hole	-8.0
Geologist	Griffith

Depth feet	Water content	Sample no.	Soil legend	Classification	Formation description & remarks
				N=7	Organic silt and silt with large layers of fine sand.
43					
44					
45					
46					
47					
48					
49					
50					
51					Washed hole from -51' to -75' stands open easily
52					
53					
54					
55					

NPA FORM 19 (REV) DEC 1959

PROJECT ______ PERMANENT HOLE NO ______

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

Project: Snettisham — Sheet 5 of 5
Location: N 88,680 E 92,855
Drilling agency: Corps of Engineers / Other: Star Corp
Hole No.: Field VS-7, Permanent VS-7
Name of driller: Griffith
Depth to -75.0' — Total depth of hole 67.0
Type of equipment: Wash boring
Datum for elevation shown: MSL
Date hole started 20 Sep 65, completed 20 Sep 65
El. top of hole: ±0.0' — Geologist: Griffith

Depth feet	Water content	Sample No.	Soil legend	Classification	Max size particle	Formation description & remarks
57						Organic silt and silt with large layers of fine sand
59						Washed hole from -51' to -75' stands open easily
61						Large artesian pressure at -75' depth. Water flows through two 3/8" orifices in wash bit through "A" rods to a height of 12' above surface. Flow of water is greater than 1 gal per min.
67			B-6			

NPD Form 1959 (Rev)

PROJECT ____________ PERMANENT HOLE NO. ________

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

Project: Snettisham — Sheet 1 of 1
Drilling agency: Corps of Engineers / Other: Sta 93+00 "P" Line
Hole No.: Field VS-8, Permanent VS-8
Name of driller: Griffith
Depth to -4.7 — Total depth of hole 8
Type of equipment: Hand Auger
Type of samples: Vane Shear (field)
Date hole started 20 Sep, completed 20 Sep
El. top of hole: +3.3 — Geologist: Griffith

Depth feet	Water content	Sample No.	Soil legend	Classification	Max size particle	Formation description & remarks
1				Vane Shear 1550 lbs/ft²		Fiborous black partly decomposed grass and silt
2				1300 lbs/ft²		
3				1550 lbs/ft²		Grey silt and small layers of organic silt and undecomposed grass
4				1550 lbs/ft²		
5				1550 lbs/ft²		grey silt and small layers of organic silt
6				2070 lbs/ft²		
7						Gravelly sand
8						

NPD Form 1959 (Rev)

PROJECT ____________ PERMANENT HOLE NO. ________

Revision	Date	Description	By

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED: R. Griffith
DRAWN: R. Griffith
CHECKED: D. Hansen
PREPARED:

SNETTISHAM PROJECT, ALASKA
FIRST STAGE DEVELOPMENT
VANE SHEAR

LOG RECORDS NO. 3

SUPERVISED: M. T. Dixon — Chief, Geology Section
SUBMITTED: [signature] — Chief, Foundation & Materials Branch
RECOMMENDED: Warren George — Chief, Engineering Division
APPROVED: [signature] — Colonel, CE, District Engineer
SCALE
DATED: 10 Dec 65
FILE NUMBER
SHEET OF

UNITED STATES-DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

GEOLOGIC LOG OF DRILL HOLE

FEATURE Speel Inlet Powerplant PROJECT Snettisham STATE Alaska
HOLE NO. 1 LOCATION Powerhouse Site COORDINATES GROUND ELEVATION 13.7 ANGLE FROM VERTICAL V
BEGUN 10-18-58 FINISHED 10-22-58 DEPTH OF OVERBURDEN 11.2 TOTAL DEPTH 36.2 BEARING OF ANGLE HOLE 0
DEPTH OR ELEV OF WATER TABLE Not recorded HOLE LOGGED BY J. Bradley R. V. Berryhill USBM FOREMAN V. Pinneo

NOTES On water table levels, water return, character of drilling etc	TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS DEPTH (FT) FROM	TO	LOSS IN (GPM)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)	ELEVATION	DEPTH	CLASSIFICATION AND PHYSICAL CONDITION
Water returns very good during drilling AX Co.	AX								1.8	Sand and gravel, roots, Brown colored.
									3.3	Granite boulder
										Sand and gravel. Very fine sand to fine gravel, occasional larger rocks. Water returns light brownish colored.
		70							11.2	Quartz diorite with some surface alterations. Chloritization Black and white colored. Cores to .6 long.
		100							13.3	Quartz diorite with some horoblende, rich phases, some disseminated pyrite, some minor slickenslides. Gray colored. Cores to 2.8' long.
		100							19.7	Quartz diorite, much finer grained, no pyrite visible, some minor slickenslides. Gray colored, some joints approximately 45° with core. Cores to 2.0' long
		100								
		100								
		100	Hole bottomed at 36.2'							

UNITED STATES-DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

GEOLOGIC LOG OF DRILL HOLE

FEATURE Speel Inlet Powerplant PROJECT Snettisham STATE Alaska
HOLE NO. 2 LOCATION Powerhouse Site COORDINATES GROUND ELEVATION 10.1 ANGLE FROM VERTICAL V
BEGUN 10-23-58 FINISHED 10-27-58 DEPTH OF OVERBURDEN 29.1' TOTAL DEPTH 56.0' BEARING OF ANGLE HOLE 0
DEPTH OR ELEV OF WATER TABLE 4.1' HOLE LOGGED BY J. Bradley R. V. Berryhill USBM FOREMAN V. Pinneo

NOTES On water table levels, water return, character of drilling etc	TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS DEPTH (FT) FROM	TO	LOSS IN (GPM)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)	ELEVATION	DEPTH	CLASSIFICATION AND PHYSICAL CONDITION
Water returns very good during drilling	AX								4.1	Sand, fine to course, loose, light brown colored.
										Sand and gravel, fine sand to fine gravel, loose, light brown colored.
									10.3	Sand, gravel, rocks, fairly firm, water returns brownish colored.
										Granite boulder.
										Sand and gravel, hard packed, water returns brownish colored.
									17.7	Granite rocks.
									18.6	Sand and gravel, fairly loose, water returns brownish colored.
							21.6		20.9	Rocks and gravel, hard packed, water returns brownish gray colored.
							23.3		23.0	Sand, fine, loose, water returns brownish gray colored.
AX Co.							29.1		28.5	Rocks and gravel, hard packed, water returns gray colored.
		100								Quartz diorite with some very quartz rich phases, gray to greenish colored. Cores to 1.2 long.
		100					40.4			Altered diorite, mica quite evident megascopically. Gray to greenish colored. Cores to 1.1 long.
		100							46.0	Quartz diorite with some quartz rich phases. Texturally all core is medium grained, some minor slickenslides. Gray to grayish white colored. Cores to 2.3' long. No pyrite noted in hole.
		100	Hole bottomed at 56.0'							

UNITED STATES-DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

GEOLOGIC LOG OF DRILL HOLE

FEATURE Long Lake PROJECT Snettisham STATE Alaska
HOLE NO. 3 LOCATION Same as DH-4 COORDINATES GROUND ELEVATION 821 ± ANGLE FROM [redacted] Horizontal 50°
BEGUN 9-17-58 FINISHED 9-18-58 DEPTH OF OVERBURDEN ? TOTAL DEPTH 24.3 BEARING OF ANGLE HOLE N 60 E
DEPTH OR ELEV OF WATER TABLE Not recorded HOLE LOGGED BY Bogins FOREMAN Bogins

NOTES On water table levels, water return, character of drilling etc	TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS DEPTH (FT) FROM	TO	LOSS IN (GPM)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)	ELEVATION	DEPTH	CLASSIFICATION AND PHYSICAL CONDITION
	AX	100								BOULDER, (Gneiss) hard.
	D	0							5.8	CAVERN
Lost drill water 14.9		47							9.3	BOULDERS & SAND. Ironstained joints. Quartz stringers up to 1/2" wide. Boulder surfaces weathered and worn.
Hole filled up to 18.0' with sand in 1 hour. 21.7		42	21.7	24.3	Could not seal packer.					
		85							24.3	

UNITED STATES-DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

GEOLOGIC LOG OF DRILL HOLE

FEATURE Long Lake PROJECT Snettisham STATE Alaska
HOLE NO. 4 LOCATION Left Abutment COORDINATES GROUND ELEVATION 821 ± ANGLE FROM VERTICAL V
BEGUN 9-10-58 FINISHED 9-27-58* (See notes) DEPTH OF OVERBURDEN 60.8' TOTAL DEPTH 75.0' BEARING OF ANGLE HOLE 0
DEPTH OR ELEV OF WATER TABLE Not recorded HOLE LOGGED BY Bogins & Judd FOREMAN Bogins

NOTES On water table levels, water return, character of drilling etc	TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS DEPTH (FT) FROM	TO	LOSS IN (GPM)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)	ELEVATION	DEPTH	CLASSIFICATION AND PHYSICAL CONDITION
Collar is 9' above low water, 7' above high water. Lost water return. 6.4'		100, 100, 80, 100, 60, 50, 100, 43	6.8	16.8	Packer would not seal					BOULDERS. Gneiss, soft to hard. Pyrites. Wide quartz stringers. Iron-stained joints. Some vertical fractures at 4.4 - 6.4. Sand and silt fill crevices between boulders at 10.9 - 11.6. Considerable weathering and iron staining from 11.6 - 15.1. Core up to 1.1' long.
No water return. 11.6' 15.1'		0							15.1	SAND and GRAVEL.
Hole filling with sand 16.8'. Hole filling with sand 20.0'.		63							16.8	SAND, GRAVEL and BOULDERS. All boulder surfaces worn smooth.
Sand coming in casing at 20', hole at 26.7'.		12	26.7	31.7	Could not seal packer					
Overnight the hole filled with sand to 2.5' up into casing with casing at 30'. No water return since 6.4'.		12, 9							33.4	Fine SAND and small PEBBLES. BOULDERS of gneiss, fairly soft.
		0							41.0	SAND and BOULDERS. Mostly boulders with sand filling cracks. Iron-staining on cracks. Bad to shoot large rocks 41.0 - 47.4.
No water return, casing at 56.4'.		16							58.4	SAND and GRAVEL. Heavy deposits of PYRITES. Considerable quartz.
Drill water return at 60.8'.		0, 100, 92	65.0	75.0	0, 0, 8.25	25, 50, 100	5, 5, 5		61.0	HORNBLENDE GNEISS and GRANITE GNEISS. Greenish-gray to almost white. Very hard. Core pieces up to 60". One healed fracture at 63'. Schistosity is about 50° to core axis (from horiz.) No joints.
		100, 100							72.5	GRANITE GNEISS. Very hard.
* Stopped drilling at end of 9/17 shift, resumed drilling 9/22.									75.0	

EXPLANATION

CORE LOSS / CORE RECOVERY

Type of hole: D=Diamond, H=Haystellite, S=Shot, C=Churn
Hole sealed: P=Packer, Cm=Cemented, Cs=Bottom of casing
Approximate size of hole (X series): EX=1 1/2", AX=1 7/8", BX=2 3/8", NX=3"
Approximate size of core (X series): EX=7/8", AX=1 1/8", BX=1 5/8", NX=2 1/8"
Outside diameter of casing (X series): EX=1 13/16", AX=2 1/4", BX=2 7/8", NX=3 1/2"
Inside diameter of casing (X series): EX=1 1/2", AX=1 29/32", BX=2 3/8", NX=3"
ANGLE HOLE / VERTICAL HOLE

APPENDIX C DESIGN MEMORANDUM NO. 7 PLATE 40

1266-66

PART II DIVING RECONNAISSANCE IN LONG LAKE

DIVING RECONNAISSANCE IN LONG LAKE, ALASKA

Report to

The District Engineer

Department of the Army

U. S. Army Engineer District, Alaska

Corps of Engineers

Anchorage, Alaska

Submitted in partial fulfillment of the requirements

as stated in contract DA-95-507-CIVENG-66-11 (NEG) by

Erk Reimnitz

September 12th, 1965

DIVING RECONNAISSANCE IN LONG LAKE, ALASKA

by

Erk Reimnitz and Neil F. Marshall

In the last week of August, 1965, an underwater geologic reconnaissance near the outlet of Long Lake, Alaska, was undertaken. SCUBA, underwater television, photography, and other methods, were employed by two diving geologists for the purpose of extending geological studies of the area to the lake bottom, in order to aid in the evaluation of its outlet as a potential dam site for a hydro-electric plant.

Regional setting.

The dominant rock type found in the Long Lake area is quartz diorite, associated with some schist and gneiss, all of which are highly resistant to erosion.

Long Lake follows the regional geologic trends, paralleling many of the islands, channels, and inlets of Southeastern Alaska. Its present topography is largely due to erosion by glaciers which covered most of the area during the last major glaciation (Wisconsin). Thus the shape of the basin, with the steep flanks, the basement high at the outlet, and its hanging relationship to the major drainage system, is characteristic for regions affected by alpine glaciation. However, the possibility that the natural dam across the outlet represents a landslide deposit needed further investigation.

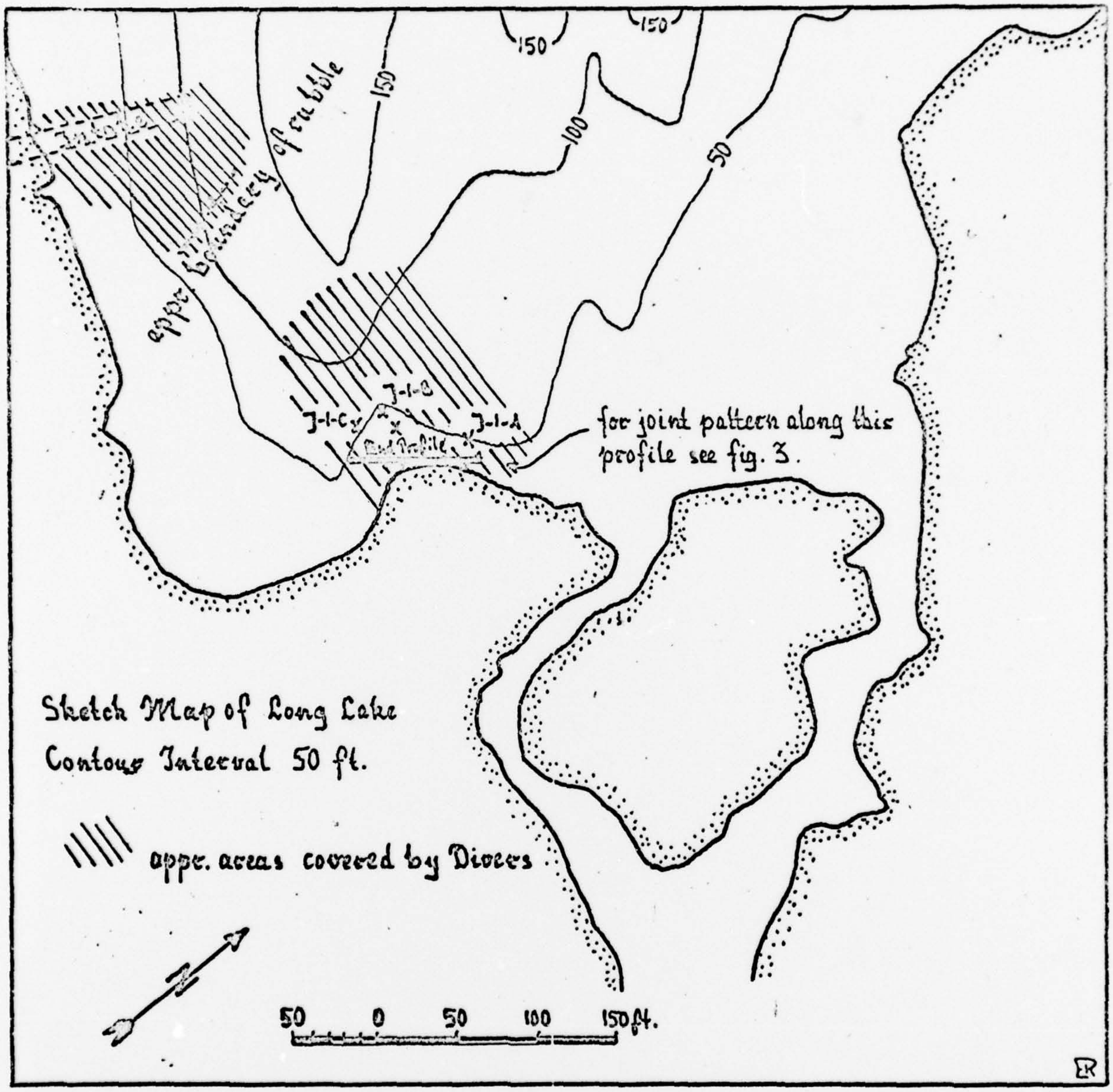
It is clear that in this area, both on the mountain flanks and on the lake bottom (see bathymetry), the topography has hardly been modified by deposition, suggesting that, after the maximum extent of the ice, its retreat was fairly rapid. Sheer mountain sides bearing glacial striae visible from distant vantage points, and the lack of soil and vegetation over large areas, suggest that deglaciation in this valley has taken place later than in the region as a whole.

Results of the present investigation.

Diving reconnaissance was concentrated in two areas: that of the proposed intake location, right abutment, and that of the steep slope of the natural dam, south of the southern branch of the outlet (see map).

Diving at the proposed intake location showed that the smooth, sheer rock face, found on the mountain side above the present lake level, continues to slope at an angle of about 45° to a depth of at least 130 ft., and the depth contours on the survey map suggest that this face continues to the bottom at a depth of about 200 ft. Several high angle joints, extensions of those on the mountain side above, were encountered below the water. Aside from two small pockets, which had collected some debris (Fig. 1), it was found difficult to even get a hand hold, and consequently any coarse material eroded from the mountain side, or supplied by ice rafting, by-passes this area and is deposited at the very lake bottom.

A paper-thin layer of brownish mud covers the slope, so that on touching it, a visible mark is left on the rock. The



150
150
150
100
50
appr. boundary of rubble
J-1-B
J-1-C
J-1-A
End Profile
for joint pattern along this profile see fig. 3.
Sketch Map of Long Lake
Contour Interval 50 ft.
appr. areas covered by Divers
N
50 0 50 100 150 ft.
EK

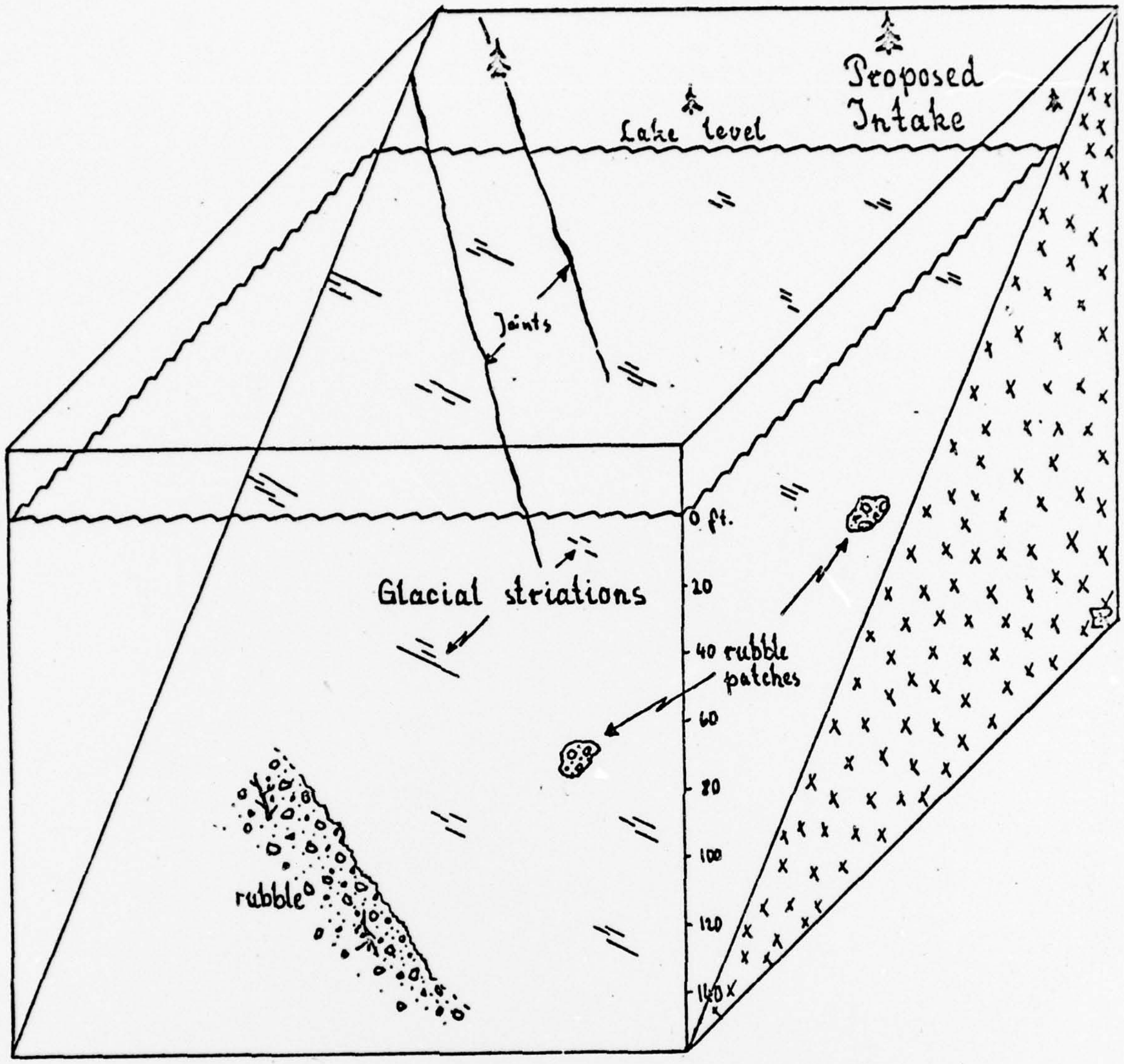


Fig. 1.- Bottom conditions at proposed intake location, right abutment.

absence of such natural marks suggests that very little material is presently traversing the steep slope.

In some areas dark colored streaks were found to extend for several inches downslope from small surface irregularities. These appear to be discolorations of the rock surface.

Glacial striae, similar to the ones seen on the mountain side above in this area, were also observed below water, and were found to slope upward toward the lake's outlet at an angle of approximately 20 to 25 degrees.

The upstream boundary of the rubble found in the southern corner of the lake, was located at a depth of 125 feet and fixed by release of a buoy. (Note: the preliminary position plotted by surveyors on the contour map shows a depth of about 85 feet, and thus should be checked.) This boundary extends upward at an angle of about 45° to the countour lines, to a depth of at least 75 feet (see Fig. 1). The thickness of this rubble, which consists largely of angular blocks of gravel and boulder size, with little mud and a few branches, was no more than a foot near the boundary, and its surface had approximately the same slope as that of the rock face. Here too, the absence of tracks caused by sliding debris on the smooth rock surface above indicates that present rates of supply are low.

In the investigation of the upstream face of the natural dam across the outlet, several interesting observations were made:

a) Portions of this cliff are overhanging.

b) Glácial striations and broad gouges trend vertically

across the steep cliff.

c) Low angle joints, similar to those noted on the down-stream side, are found.

d) The extremely soft sediment fill at the foot of the cliff, resting at the angle of repose, is littered with sticks, branches, and large trees.

These observations will be treated in some detail.

The upstream face of the natural dam across the lake's outlet, well rounded in the upper reaches by ice action, becomes steep to vertical at a depth of about 15 feet, and in some places is overhanging below about 30 feet (see Fig. 2). Its surface in the undercut portions contrasts very much from that of the upper rounded portions by the hackly, plucked, irregular relief. Individual faces represent smooth fracture planes, but protrusions and corners are sharp. No measurements were made on the amount of undercutting, but it is estimated at 6 to 8 feet.

Glacial striations can be observed on the face of the natural dam to a depth of 50 feet. The deeper occurrences were noted near the outlet, where the cliff is not overhanging. Striations consist both of well defined grooves and ridges and of broad, elongated depressions. They either traverse the face vertically, or point toward the lowest section of the dam near the outlet.

Based on the above observations the following conclusions seem justified: The natural dam across the outlet of Long Lake is not the result of landslide action, nor of tectonism. Its location could be controlled by one or more small fracture zones

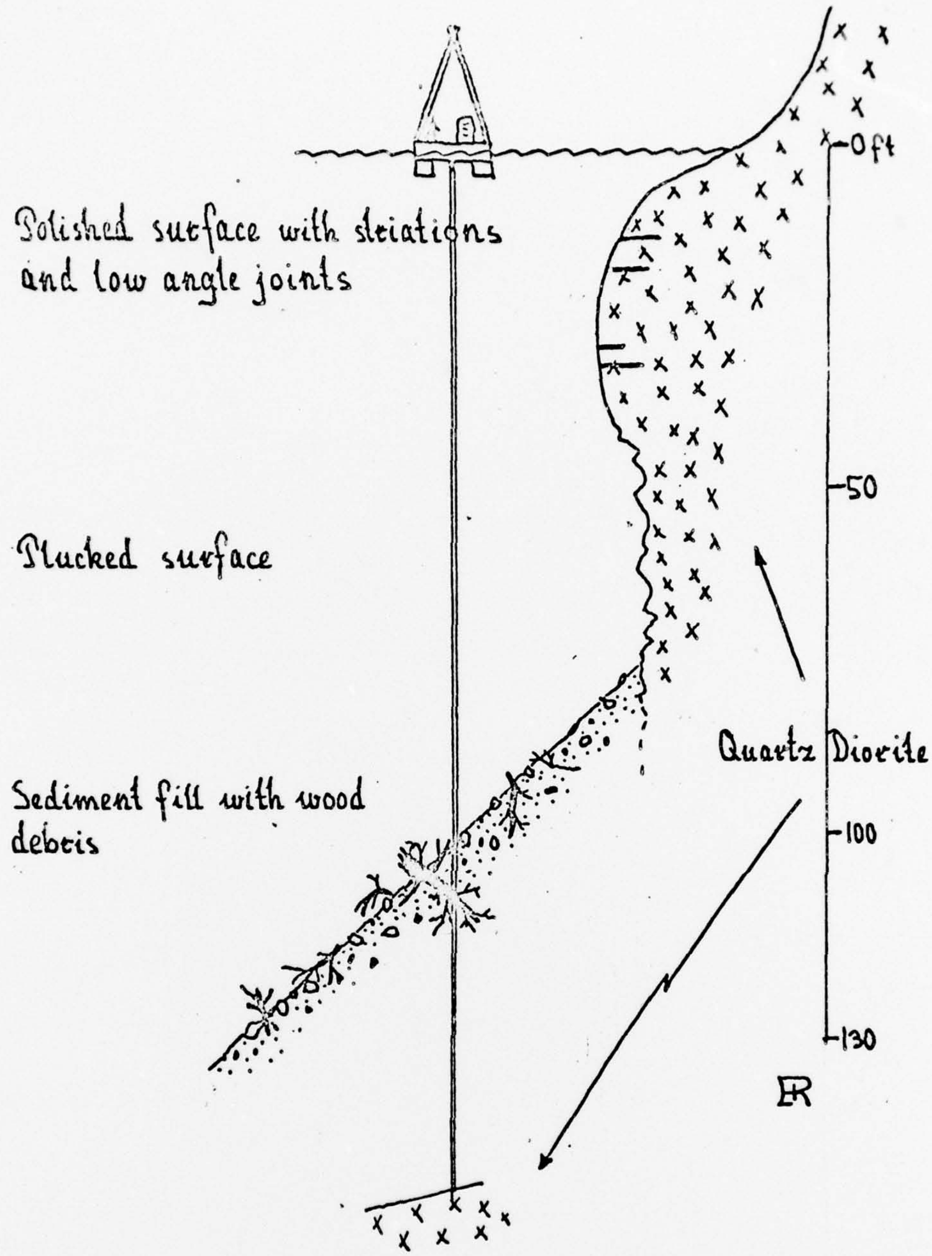


Fig. 2.- Generalized crossection of upstream face of natural dam across Long Lake (~ sta. J-1-B).

trending across the lake, one of which coincided with the upstream face. During the maximum extent of the ice the dam as a resistant rock unit withstood its pressure and abrasive forces deflecting the moving ice mass upward by about 200 feet. This is further substantiated by the previously mentioned upward trending glacial striae, at the proposed intake location, right abutment.

The low angle joints in the upper portions of the dam are thought to be due to pressure release associated with the retreat and unloading of the ice (personal communications with Norman Dixon). They are discontinuous and undulating, where exposed.

Observations and measurements made on the joints below lake level show that they are quite similar to those on the downstream face (Fig. 3). The lowest one, consisting of several individual fractures, was found at a depth of about 50 feet. The joints in some places are tight, in others open by about 6-10 inches due to erosion, but always closed at a depth of about one foot from the face of the cliff. One joint was found to pinch out at a place where another one started at a slightly lower level. Another one still ended in a set of very small, sub-parallel fractures.

The pattern of the major low angle joints, as found on the upstream face of the dam, projected onto a vertical plane parallel to the dam, is indicated in Fig. 3. The joints were not traced for their full length, partly due to the poor visibility encountered in the lake. In the lower portions of the natural dam no apparent trends were noted to the jointing.

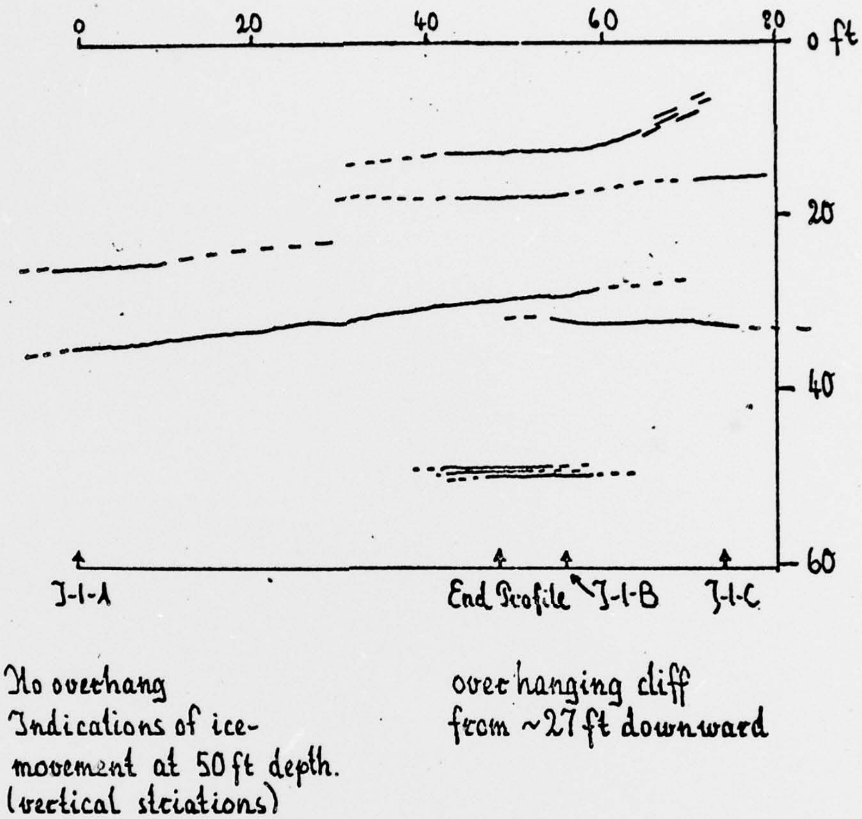


Fig. 3.- Diagram of joints surveyed on face of dam near outlet as projected onto a flat plane (see map). Dashed where inferred.

Below a depth of about 75 feet the face of the rock wall is covered by a wedge of sediment, which, in a drill hole about 20 feet from the cliff is found to be 50 feet thick. Angular boulders and slabs, up to 2 feet in diameter, were encountered on the surface of this wedge, besides material of gravel, sand, silt, and clay size. Because of the high content of silt and clay, however, a field term for this material might be soft, gravelly mud with some boulders. In fact, the high silt and clay content makes this material so soft that a diver can easily penetrate it up to the shoulder with his arm. A sample was collected and given to the chief geologist of the project, but, as some of the finer fractions were washed out during the operation and later ascent, it may not be representative. The presence of numerous twigs, branches, and even trees, in this sediment is striking. One complete tree with a diameter of about one foot at the butt, was found at a depth of 105 feet. Of the area traversed, about one fifth was covered by wood debris. Two wood samples were collected and given to the chief geologist for possible C^{14} analysis. Such age determinations would throw light on the rate of accumulation for wood debris in this area. We believe that this type of material would pose no problem in the operation of the hydro-electric plant.

Indicates need for trash racks [illegible]

The mechanism of accumulation for the sediments at the foot of the cliff is not too well understood. Since the dam itself, except for its undercut portions, could not have contributed significant amounts, the source must be looked for elesewhere.

The smooth rock surfaces at the intake location, right abutment, extending to the lake bottom, as well as the relief of the bottom in this area, attest to the slow rates of deposition in the lake as such. It seems conceivable, however, that floating wood, ice, and possibly avalanche snow with incorporated sediment, is gathered by wind against the outlet, and that therefore rates of deposition here are higher than elsewhere in the lake. To establish this point, wind patterns should be defined as well as observations made during breakup of the ice.

Another, perhaps more likely explanation for the greater bulk of the fill, has it consisting of glacial drift, deposited against the dam during a time when the retreating icefront stagnated for some time, or perhaps even readvanced slightly. Since the lake was filled with water since the ice cleared its lower portions, the undercut relationship of the natural dam is difficult to explain by any mechanism except ice plucking.

Miscellaneous observations.

A number of miscellaneous observations made during the diving may be worthwhile mentioning.

The water temperature in the lake was about 38° F. During the diving operation, visibility near the outlet was extremely poor. Daylight did not penetrate deeper than 25 to 30 feet. A large amount of fine suspended matter was noted in the water and possibly was due to the drilling operation in the lake. Near the intake location at a depth of about 70 feet, the water became clearer and visibility with the aid of the TV light was

10-15 feet, but daylight did not penetrate the upper dirty layers of the water.

No currents were noticed on the lake bottom, even near the outlet. The branches and twigs found on the bottom support a ridge of fine sediment, which is easily put into suspension on touch, and then very slowly settles to the bottom.

The only indication of life in the lake were some small cemented sand tubes, up to one inch in length, found at depth hanging along cracks in the rocks.

Part of the diving operation involved the retrieval of a 70 foot long section of drillers pipe, which had been lost near the drilling barge.

Conclusions.

The diving reconnaissance in Long Lake showed that:

a) The natural dam across the outlet could not represent a slide block since it existed during the last glaciation.

b) The set of low-angle joints extends to the upstream face of the dam, and appears similar to those studied in other parts.

c) Rates of deposition in the lake are low.

d) Wind drift could account for some of the material piled against the dam. More probable from ice rafting

Joint patterns and the sediment-rock wall interface on the upstream face of the dam were surveyed, as well as the boundary of the rubble near the intake location, right abutment.

APPENDIX

Five pictures, taken with a 35 mm Calypso camera and flash, are shown. The extremely murky conditions in the lake, well demonstrated by Photo 3, are responsible for the poor quality of the pictures. Here the mercury-vapor lamp of the underwater television camera, illuminating a rod calibrated in feet, barely shows at a distance of four feet.

(Photos not included in DM-7)